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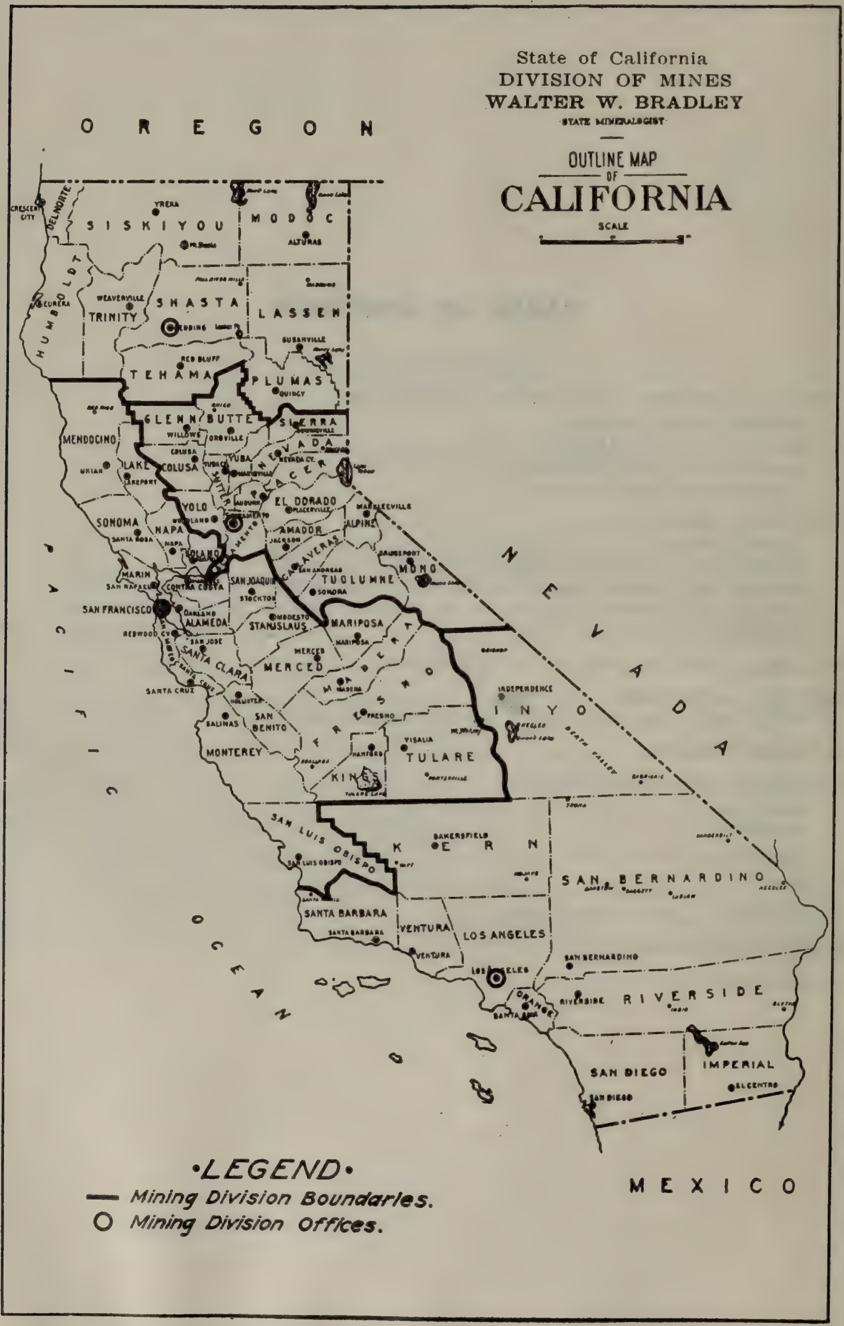

State of California
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

OUTLINE MAP OF CALIFORNIA

SCALE
OREGON
NEVADA
PACIFIC OCEAN
MEXICO
DEL NORTE
CRESCENT CITY
SISKIYOU
YREKA
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
GLENN
WILLOWS
BUTTE
OROVILLE
SIERRA
MENDOCINO
UKIAH
LAKE
LAKEPORT
COLUSA
YUBA
MARYSVILLE
NEVADA
NEVADA CY.
SUTTER
PLACER
AUBURN
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
ALPINE
MARKLEEVILLE
SONOMA
SANTA ROSA
NAPA
SOLANO
AMADOR
JACKSON
CALAVERAS
SAN ANDREAS
MONO
BRIDGEPORT
MARIN
SAN RAFAEL
CONTRA COSTA
SAN JOAQUIN
STOCKTON
TUOLUMNE
SONORA
SAN FRANCISCO
OAKLAND
ALAMEDA
STANISLAUS
MODESTO
MARIPOSA
REDWOOD CY.
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
FRESNO
INYO
INDEPENDENCE
DEATH VALLEY
MONTEREY
HANFORD
TULARE
VISALIA
PORTERVILLE
KINGS
SAN LUIS OBISPO
KERN
BAKERSFIELD
SAN BERNARDINO
NEEDLES
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
SANTA ANA
RIVERSIDE
SAN DIEGO
IMPERIAL
EL CENTRO

•LEGEND•
— Mining Division Boundaries.
○ Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from MINING IN CALIFORNIA to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given County (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).
3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the District Engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the State's oil fields is included under this heading.

REDDING FIELD DIVISION

CHAS. V. AVERILL, Mining Engineer

There is no report from the Redding Field Division. Mr. Chas. V. Averill, District Mining Engineer, is engaged on investigations for special reports upon various economic minerals.

SACRAMENTO FIELD DIVISION

C. A. LOGAN, Mining Engineer

Mr. C. A. Logan, District Engineer, is engaged in the preparation of a special report upon the Mother Lode Gold Belt of California, which it is planned will be published soon.

SAN FRANCISCO FIELD DIVISION

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DIVISION

W. B. Tucker and R. J. Sampson, Mining Engineers

Reports covering the mines and mineral resources of all of the counties in the Los Angeles field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

GEOLOGIC BRANCH

CURRENT NOTES

Olaf P. Jenkins, Chief Geologist

Results of special geological investigations of certain Sierran roof pendants are published in this number of the Journal. One paper is by Homer Erwin on northeastern Madera County and the other is by Evans B. Mayo on southwestern Mono County. Although the Division of Mines bore some of the field expenses of these investigations, the time and effort spent by the authors were entirely contributed by them.

A study is being made by the Geologic Branch of the conditions which govern the ancient Tertiary river channels of the Sierra Nevada, with a view to developing a more thorough, systematic, and intelligent method of exploring them for their gold content. This work is now in progress, but a preliminary statement concerning characters of regional and fundamental importance is given herewith in a brief report.

The peculiar nature of the problem suggests that effective exploration of the buried river channels should be based on a three-fold investigation: (1) surface features as shown on aerial photographs; (2) regional and detailed geological mapping, using the aerial photographs as a base; and (3) the use of geophysical methods, especially adapted to the problem at hand. No one of these lines of attack will suffice for the proper interpretation of the nature and course of the ancient buried streams, or for an accurate determination of their position and the location within them of the most favorable-appearing 'runs.'

The geophysical methods probably best adapted to this problem consist of the combined use of magnetic and various electrical instruments. To properly interpret their results, however, it is necessary that they be used in close conjunction with and considered a part of the whole detailed geological investigation.

On acount of a general interest shown in geophysical prospecting of the buried river channels, the following notes have been prepared by Mr. William Q. Wright, Jr.,* at the request of the Geologic Branch:

"When appropriate geological examination of an auriferous channel has been made, and when the characteristics and structures of the various geologic units are carefully approximated and found favorable, geophysics may enter the field with a relatively high probability of success. Geophysical prospecting has recently yielded splendid solutions to geologic problems. It seems probable that most of the 'failures' credited to geophysics in the mining field are due largely to forgetfulness that both the problem and its solution are entirely geological, even though the means of solution may reach through every branch of physics.

"Geophysical prospecting comprises, First, the measurement of natural or artificially induced forces in the earth, and Second, the interpretation of these forces in terms of locations, dimensions and characteristics of the various geologic units involved. The first phase of this work requires, of course, a high degree of field technique and judgment as to appropriate methods and locations. The second phase, however, demands all possible cooperation between geologist and geophysicist, with the careful analysis of every available factor of the problem. Sometimes a rather 'unique' mathematical solution to a set of geophysical data will not stand up under careful geological scrutiny, and one individual is not likely to have the necessary training to safely decide a difficult problem of this sort. Fortunately, such decisions are not often left to be fought out between the geologist and geophysicist. Usually one or more additional geophysical methods may be applied to the same area, and if corroborative results from this work meet the rigid geologic and physiographic requirements of the area, the conclusions should have a high degree of utility in the prediction of depths to bedrock, shape of the channel, locations of benches, water-table, etc. Under favorable conditions the probable locations of the 'richer' runs may be determined, although gold in its usual concentrations cannot be detected directly.

---

* Mining Engineer, Wright Research Laboratories, Sausalito, Calif.

"Magnetic and electrical methods have been most successful in the geophysical prospecting of gravels or buried channels. Since these two classes of geophysical methods are in general so different in theory, application and interpretation, comparative results are especially valuable and lessen considerably the uncertainties which any one method might involve. The magnetic methods involve the measurement of magnetic effects of the geologic units. It may not be a commonly recognized fact that the ordinary rocks and gravels usually have measurable magnetic differences. If these differences are not too slight or too irregular or complex, the speed and cheapness of the magnetic method commends its use. Electrical methods owe their successful operation to the relative abilities of the earth structures to conduct electric currents (or to produce them in some cases). These methods are in general more definite, more accurate, slower and relatively more expensive in application than are the magnetic methods. If the topography is not too severe, the formations not too dry or too similar as to moisture content, and if the structures are not too complex, electrical methods should yield profitable results.

"In general, the auriferous channels of California can be successfully prospected by geological means, followed by drilling wherever possible. Indeed, failing to use these modern geological-physical tools as aids toward actual mining exploitation, we will not have progressed far beyond the forty-niners, whose astonishing energy, perseverance and ingenuity we should always hold in high regard."

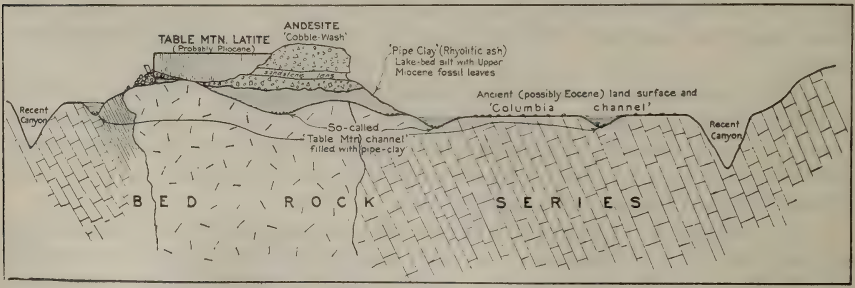
ANDESITE
'Cobble-Wash'
TABLE MTN. LATITE
(Probably Pliocene)
sandstone lens
'Pipe Clay' (Rhyolitic ash)
Lake-bed silt with Upper Miocene fossil leaves
Ancient (possibly Eocene) land surface and
'Columbia channel'
Recent Canyon
So-called 'Table Mtn channel' filled with pipe-clay
Recent Canyon
BED ROCK SERIES

FIG. 1. Diagrammatic cross-section, showing relationship of the resurrected ancient land surface, of local channels cut in it, of Upper Miocene lake-sediments which fill them and once covered other parts of the ancient surface, of the extensive series of andesite mud-flows which once spread over the entire region, but now occur only as remnants, and of the very resistant Table Mountain latite-lava which filled a river course but now stands out distinctly as a protective agent to erosion. Rich gold placers were mined from segments of the ancient land-surface-channels thus protected from erosion, but not from the covered stream course down which the Table Mountain lava flowed.

RESURRECTION OF EARLY SURFACES IN THE SIERRA NEVADA

A Fundamental Geologic Process Involved in Placer Gold Deposition*

By OLAF P. JENKINS, Chief Geologist

Quaternary erosion resulting in the uncovering of Tertiary volcanic ash and the resurrection of earlier Tertiary surfaces, formerly cut into pre-Cretaceous bedrock along the western flank of the Sierra Nevada, is a widespread geologic process which has heretofore not received the recognition it deserves. The process involves features of vast economic concern. One key locality for this study is in the region of Table Mountain, Tuolumne and Calaveras Counties, California, where a very resistant late Tertiary latite flow has served the purpose of preserving not only fragments of earlier and less resistant geologic bodies consisting of volcanic materials, mud-flows, lake beds, and stream gravels of different ages, but also the underlying bedrock surfaces of earlier Tertiary age. These ancient surfaces, the topography of which appears to have been controlled by bedrock structure, may be found in various stages of resurrection. In this area, the gold-bearing gravels were mined in ancient channels that ran in directions opposite or at an angle to the Table Mountain Channel; the latter apparently never contained any appreciable amount of gold-bearing gravel, contrary to the common belief. Though unmantled and dissected through Pleistocene and Recent epochs, fragments of upland peneplained bedrock and in places gravel-covered surfaces are actually early Tertiary land forms, which have been brought to light after having been buried throughout later Tertiary volcanic epochs.

Through the study of fossil plants preserved in the volcanic ash and lake beds, the paleobotanist recognizes ages from earliest Eocene to Upper Miocene, but the older underlying non-volcanic auriferous gravels that lie immediately on bedrock remain in most cases without definite age determination; likewise the earlier surface beneath. The time of covering is thus determined, not the time of initial stream formation, and it would seem that the volcanic covering is of an age progressively younger from north to south. Pleistocene bones have also been found on the surfaces of the unmantled early Tertiary peneplain, but they do not, unless found buried with the formation, indicate the age of the lava flows. Some mining geologists, without fossil evidence, refer the most ancient gravels to the Cretaceous, thus accounting for the stream materials which were carried during that period when the Sierras were stripped of most of their roof pendants. The gravels that were made by the Cretaceous streams, however, now form the thick beds of the upper Cretaceous or Chico formation of the Great Valley.

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* This abstract was submitted to the meeting of the Geological Society of America (Cordilleran Section) held in Berkeley, April, 1934.

In general, some of the richest ancient channels mined have certainly proved to be the oldest. They contain well water-worn quartz pebbles, together with metamorphic and other hard crystalline rocks, but are void of Tertiary volcanics. The correlative still-water-laid sediments of the Ione (Eocene), occurring along the western edge of the Sierra Nevada, which contain fine clay deposits interbedded with lignite and quartz sands, appear to have experienced a tropical or subtropical climate. This period antedated the faulting of the east front of the Sierra and it is possible that the streams of that time headed far to the east of this present scarp. The development of the forest-covered peneplains and large meandering streams characterized the early period. The tropical climatic conditions, together with the peneplained topography, resulted in the breaking down of feldspathic gold-bearing rocks. Quartz fragments and gold particles were released, while feldspar decomposed to clay. Later rejuvenation, by initial Sierran uplift of the westward-flowing streams and tributaries, caused a large quantity of these materials to be thrown into the stream channels. The quartz particles were shaped into gravels and the clays were washed out into the Ione sea. The gold was left behind in bedrock riffles.

As the climatic and topographic conditions changed, it is thus conceived that no large amount of gold comparable to its early release was further freed. It even appears that the greater part of all placer deposits in the Sierra Nevada represents the reworking of these early Eocene-released gold particles.

Stream piracy, caused by rejuvenated westward-flowing tributaries of the larger, original, structurally-controlled and more northward flowing rivers, is considered to be a process of major importance in the adjustment of Tertiary drainage and in the deposition of its enormous thicknesses of gravel accumulated prior to the covering of later ash and mud flows, which mantled practically the entire western flank of the northern Sierra Nevada. The positions of both the intervolcanic streams and those streams that consequently flowed over the top of the mud-filled region and were later incised, had no relationship to the positions of the earlier, more auriferous gravel channels. These fundamental and regional characters are found to fit into the economic picture of the placer deposits.

GEOLOGY AND MINERAL RESOURCES OF NORTHEASTERN MADERA COUNTY, CALIFORNIA

By HOMER D. ERWIN *

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* Temporary field geologist, Geologic Branch, California State Division of Mines.

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ABSTRACT

The area, described in this report, lies in the extreme northeastern portion of Madera County, California, immediately east of the crest of the Sierra Nevada in the headwaters of San Joaquin River, and is known as the Minaret District. Extremely rugged and glaciated mountainous topography prevails over the entire area, including Sierra Crest, Ritter Range, and San Joaquin-Merced Divide which embrace the canyons of the North and Middle Forks of San Joaquin River.

The geology of the Minaret District is essentially that of an attached roof-pendant of highly-folded Mesozoic strata which have been intruded by granitic rocks and, in part, overlain by much later volcanic materials. The metamorphic rocks consist of meta-volcanic tuffs and flows with intercalated limestone and slate.

Orogenic forces folded and subjected the beds to cataclastic (crushing) and dynamic metamorphism. Originally the rocks were

formed by accumulation of materials, deposited largely in a marine environment, as the result of offshore vulcanism and sedimentation during upper Triassic and lower Jurassic time. The volcanic materials were altered chiefly into mylonitic (completely crushed) rocks consisting of meta-tuffs and flows which generally show relict clastic or porphyritic textures. More completely altered rocks are shown by pseudo-schistose and schistose rocks. Clay sediments were changed to slate, and limestones to marble. In general, the metamorphic rocks, excepting the limestone, suffered little alteration as the result of igneous intrusion or related activity. Epidote is a common mineral in the metamorphic as well as the earlier intrusive rocks.

The intrusive igneous rocks are represented by five types: andesine-diabase, diorite porphyry, diorite, quartz monzonite-diorite, and micropegmatitic granite. These rocks, intruded in an order of increasing silicity, are the result of one general period of igneous invasion. The intermediate rocks compose the main mass of the Sierra Nevada batholith while the more acidic and basic types occur as closely associated bodies of smaller extent, as irregular stock or dike-like bodies, and marginal facies. The age of the batholith is regarded as late Jurassic or early Cretaceous.

Later volcanic lavas and pyroclastic materials overlie the eroded surface of the metamorphic and igneous rocks. These were formed in several distinct ages. The older group includes lower basalt and upper andesite which is regarded as late Tertiary in age. A younger group includes basalt which is interglacial in age and probably early Pleistocene. Following the retreat of Pleistocene glaciers, pumice, blown from outside sources, was showered over the eastern portion of the region, forming a thick mantle on the surface. In places this material has become mixed with recent stream and reworked glacial sediments.

The surface features of the Minaret region are the result of long pre-glacial stream erosion, with later glacial modification, acting upon two important general types of rocks. The highly folded metamorphic rocks are not only the more resistant to erosion but offer a profound structural control, as contrasted to the generally more homogeneous granitic rocks. Mountain crests and canyons generally conform with the northwesterly strike of the metamorphic rocks but in the areas of granite this trend is lacking.

Upon leaving the metamorphic areas, the streams change to a westerly direction, determined by the general tilt of the mountain block. Critical uplifts during the history of the range have resulted in pre-glacial erosion that produced several definite topographic forms. These include the development of a broad valley plateau, into which high valleys and deep canyons have been successively cut. The old plateau-like surface with corresponding summits was developed by a long period of stream erosion, which existed probably from the Cretaceous up to the end of the Tertiary. The mountain valleys developed in the late Pliocene and the canyons were formed during the early Pleistocene from accelerated stream erosion caused by uplifts of the range. Pleistocene glaciation modified the stream-cut topography to the present more-rounded, glacier-sculptured form.

Folding, faulting, and jointing involve the rocks of the Minaret region. The degree of folding in the metamorphic rocks is generally isoclinal and the axes trend in a northwest direction and have a high dip to the southeast. The strike is normally N. 35° to 45° W. and the dip is around 75°, to the southwest, although from this there is considerable deviation. The number of folds involving the metamorphic rocks is not known. Faulting includes low-angle thrusts, reverse, and normal faults. Generally, these conform closely with the schistosity of metamorphic rocks and are known as strike-faults. The displacements are not great and appear to be of little importance. Jointing is generally well developed in most of the rocks and has been an important factor in the erosion of the region.

The ore deposits of the Minaret Mining District in northeastern Madera County are quite varied both mineralogically and typically, but represent the same general period of mineralization. This period was post-granitic and pre-volcanic, probably early Tertiary in age. As the deposits occur in a high mountain region which has been glaciated, the ore is necessarily of primary character and has suffered little oxidation. The ores are essentially base metal and include principally iron, lead, zinc, copper, and silver with minor amounts of molybdenum, tungsten, and bismuth. Among these, iron, lead, zinc, and silver are the most abundant while the rest are generally subordinate. The deposits are grouped into the following classes on a basis of the dominant metal or metals present. The larger or more extensive occurrences include (1) iron, (2) lead-zinc, and (3) silver, while the minor deposits include (4) copper, (5) molybdenum, and (6) tungsten.

The magnetite deposit, on the west slope of Iron Mountain constitutes the most important occurrence of ore in the Minaret region. The deposit occurs as a somewhat massive and elongated body near or at the contact of granitic and metamorphic rock with the longer dimension of about 500 feet generally conforming with the northwesterly strike of the metamorphic rocks. The ore generally forms large masses and veins in the metamorphic rocks and veinlets or disseminations in the granitic rock. The magnetite is non-titaniferous with actinolite and plagioclase feldspar as common associated minerals.

The lead-zinc deposits fall into two general classes which include (1) the deposits in limestone, and (2) those deposits which form veins. The first class is the most important. In this, the ore consists principally of silver-bearing galena and sphalerite with admixtures of chalcopyrite and pyrite. As such, the ore occurs as irregular masses, lenticles, veinlets, and disseminations in a highly-altered limestone which is interbedded with steeply-dipping meta-volcanic rock. The development of silicate minerals in the limestone has given abundant epidote, garnet, and actinolite. This alteration preceded the metallization. The ore was localized along pre-mineral fractures subordinated with replacement. The ore values are confined chiefly to a variable silver content in galena. The important mineralizations of this class are found in the upper Minaret and Shadow Creeks.

The true vein deposits of lead and zinc are of less extent. In these, galena and sphalerite occur chiefly in quartz veins and stringers and conform with the strike of the metamorphosed volcanic rocks in which they occur. This includes principally the mineralizations in the vicinity of Agnew Meadows, Minaret Summit, and in Upper North Fork.

A silver-bearing deposit is found about two miles north of Agnew Meadows. This mineralization includes a silver-bearing, lead, and bismuth ore along with chalcopyrite, pyrrhotite, and sphalerite. The ore occurs in quartz veins and veinlets near or on the contact of a metamorphosed rhyolitic tuff and argillaceous slate.

Lesser deposits include the occurrence of copper as chalcopyrite in the upper King Creek, tungsten as wolframite in the upper Iron Creek, and molybdenum on the east slope of Red Top Mountain. All of these are vein deposits.

INTRODUCTION

The Minaret Mining District of northeastern Madera County, which was formerly known as the North Fork Mining District, has probably drawn more attention in recent years than any other single region in the higher Sierra Nevada. One group of interests has desired to annex the region to the present Yosemite National Park and thus to effectively preserve its scenic beauty while another group has desired to retain the land in the National Forest, principally because of certain economic mineral showings, and to allow mining activity to continue. The region holds many attractions for the nature lover, camper, sportsman, and mountain climber as well as the prospector and sheepman. A discussion of the merits for and against the inclusion of the area in the park have been presented by Bradley.[1]

Mining development up to the present time has not reached beyond the prospect stage. Although mineral indications are fairly good for silver, lead, zinc, and copper, no commercial mines have been developed. One notable deposit is the magnetite deposit of Iron Mountain. Conservative estimates state that from four to seven million tons of high-grade iron ore are available. This deposit especially has attracted much attention and stimulated search for ore elsewhere in the region.

Historical Sketch

Among the earliest white men to be attracted to the region were sheepmen who came into the country in the sixties. Attention to the mineral possibilities of the country, however, lay dormant until early in the eighties, when deposits on Iron Mountain and King Creek were located. The iron deposit especially drew early attention to economic mineral possibilities of the region.

Pioneer prospect work in the region was curtailed by an act of Congress, passed October 1, 1890, which placed the land within the boundaries of the Yosemite National Park. Following much controversy, the land was withdrawn from the Park by a change of the park boundaries which was executed by an act of Congress passed February 7, 1905. The restoration resulted in renewed interest in the development of the possible mineral resources in the region. The more important early locations were relocated and prospecting began anew. These include the Iron Mountain group (1905), and the Nidever group

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[1] Bradley, W. W., The Minarets District, Madera County, California: California State Min. Bur. Twenty-second Ann. Rept., pp. 539–557, 1926.

(1909–12). Among the early locators are Tom Agnew, C. J. Beck, Tom Beasore, Jim R. Sullenger, and Dave C. Nidever.

Activity was later increased during the World War and many new locations were made, but no real mining operations were undertaken, principally because of the lack of transportation facilities. Such locations include certain deposits on the east slope of Middle Fork Canyon and on Minaret, King, and Iron Creeks and Upper North Fork Canyon. In recent years several mining companies have been organized for mining exploitation but no extensive operations have been performed up to the present time. Such organizations include the Minaret Consolidated Mines Company, the Agnew Meadows Mining Corporation, and the Minaret Mining Company.

Since the withdrawal of the land from the Park, a group of interests have endeavored to seek a congressional act which would restore a portion of the region to the Yosemite National Park. This activity continued until a commission, appointed to investigate the region, submitted a report which recommended that the area be included in the Park but it drew such a storm of opposition from the mining interests that the measure was finally dropped.

Acknowledgments

Despite the varied interests given the region, no systematic geological work had been undertaken prior to 1930. Realizing the need for detailed information, the Geologic Branch of the California State Division of Mines assigned to the writer the problem of mapping the geology of the region combined with a study of the ore deposits. The field work was carried on for two months during the summer of 1930 and continued for three months during the summer of 1931. Laboratory work, connected with field study, was carried on at the University of California.

To Walter W. Bradley, State Mineralogist, and Olaf P. Jenkins, Chief Geologist of the California Division of Mines, the writer extends his kindest appreciation for their sponsorship and helpful cooperation in the work.

The writer is also indebted to Dr. Evans B. Mayo of Cornell University who on a number of occasions assisted the writer in the field and gave valuable suggestions and criticism on the geologic problems involved.

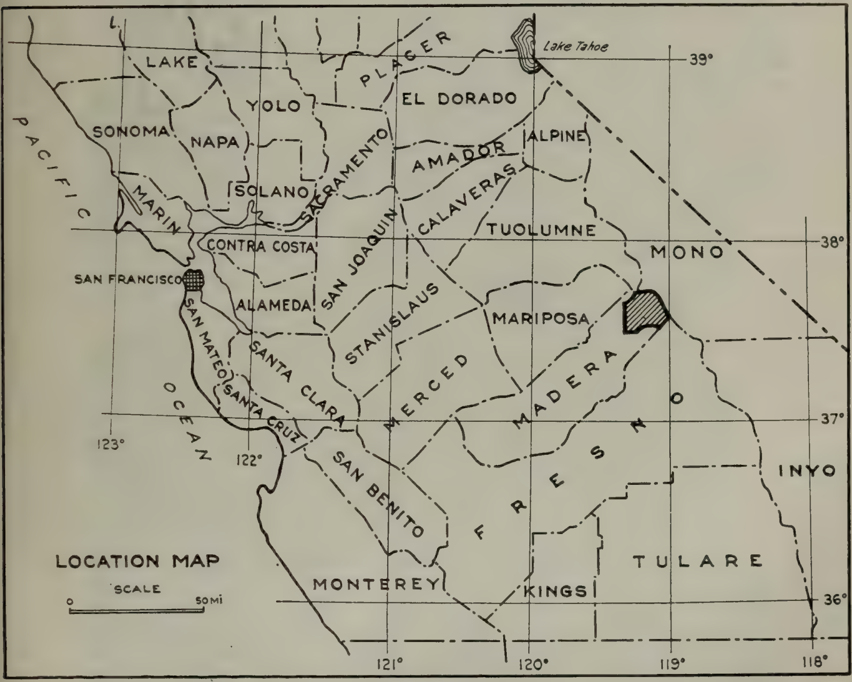
The claim-holders unanimously extended their most cordial assistance in the work for which the writer takes this opportunity to extend his appreciation. Special thanks are due to Mr. W. H. Blackburn of the Treadwell-Yukon Company, Mr. C. C. Randall of the Minaret Consolidated Mines Company, Messrs. F. P. Shaw of the Agnew Meadows Mining Corporation, D. C. Nidever, J. R. Sullenger, and S. P. Burris. Special thanks are due to Mr. Malcolm McLeod, district ranger, for whose valuable information and kind hospitality the writer is very grateful.

Location and Accessibility

The area described in this report includes about 240 square miles and lies in the extreme northeastern portion of Madera County, California, occupying the upper headwaters of North and Middle Forks of San Joaquin River. It is embraced in a rugged mountainous region which lies immediately west of the main crest of the Sierra Nevada at about the middle portion of the range. The total area surveyed geologically includes about 240 square miles. It is part of the Sierra National Forest which lies in the lower half of the Mount Lyell quadrangle, mapped by the U. S. Geological Survey, on a scale of 1:125,000, in 1898–99.

There are no places of year-round habitation within the area as the winter season is too severe. Under normal conditions only late spring, summer and early fall give satisfactory living conditions.

Access to the region is made by one auto road and several trails. The approach by road is from the east and is made by way of Mammoth Lakes P. O. over Minaret Summit to Agnew or Reds Meadows. This road is a branch of the main highway between Mono Lake and Owens Valley. The town of Bishop is about 45 miles southeast of the Mammoth Lakes region.


Lake Tahoe
39°
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36°
LAKE
YOLO
PLACER
EL DORADO
SONOMA
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ALPINE
AMADOR
SACRAMENTO
SOLANO
CALAVERAS
MARIN
TUOLUMNE
PACIFIC
OCEAN
CONTRA COSTA
SAN JOAQUIN
MONO
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
SANTA CRUZ
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SAN BENITO
TULARE
KINGS
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LOCATION MAP
SCALE
0
50 MI
123°
122°
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120°
119°
118°

FIGURE 1.

Approaches by trail are as follows: from the north, over Island and Agnew Passes; from the east, over Deadman and Mammoth Passes; from the south, by way of Fish Valley and various trails out of the south fork basin; and from the west, by way of Clover Meadow and Fernandez and Isberg Passes. The Forest Service as well as the mining people have done extensive trail-building throughout the region and as a consequence there is a network of good trails offering easy travel between points.

Mammoth Lakes P. O. and vicinity to the east of the region and Beasore Meadows on the west are the nearest places where supplies

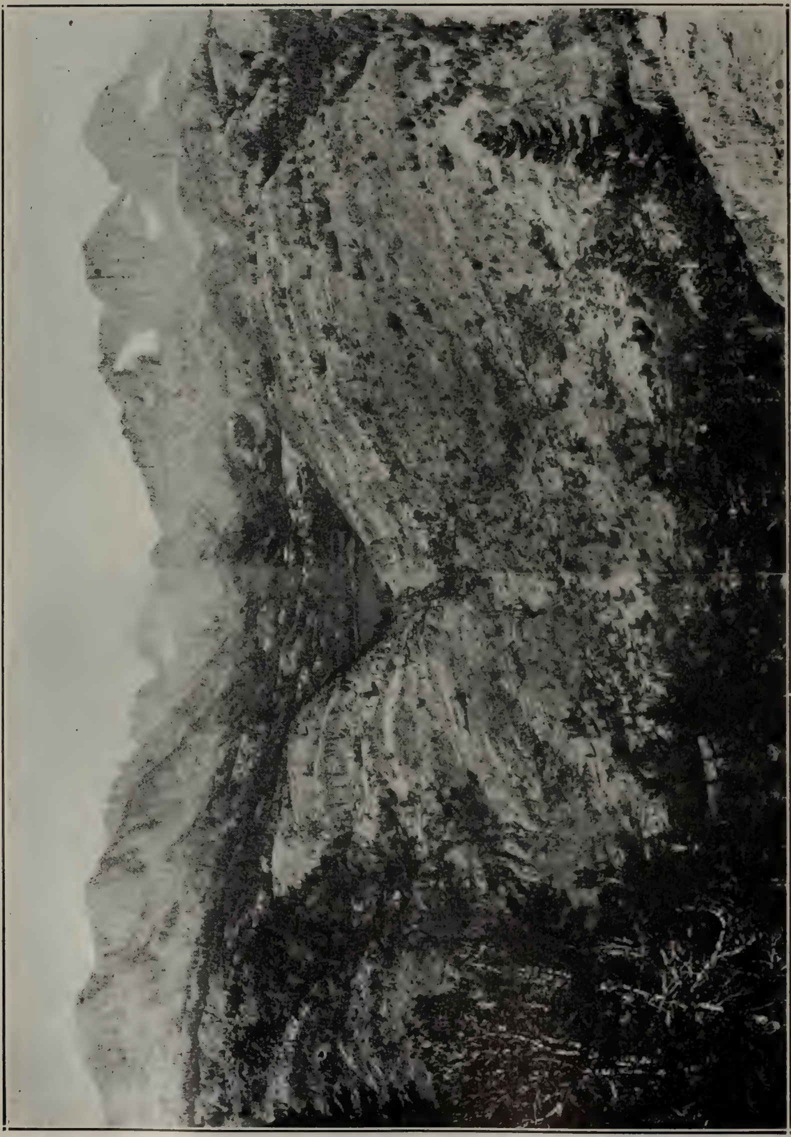

FIG. 2. The Minarets, Ritter Range, and west side of canyon of Middle Fork of San Joaquin River, looking westerly from Sullenger (Tom Agnew) group of claims, Shadow Lake and canyon of Shadow Creek in center. The Nidever group of claims is at the head of Shadow Creek, in the dark zone just in front of Ritter Range. Note the dark and light bands of the various metamorphic units; the lighter being meta-rhyolitic tuffs.

Photo by Walter W. Bradley.

and gasoline can be obtained during the summer months. Hotel accommodations are available at various lodges in the Mammoth Lakes locality. A scheduled bus service is maintained during the summer months between Mammoths Lakes P. O., Bishop, and points south. Riding and pack-animals can be hired for travel into the mountains.

SURFACE FEATURES

Topography

Situated in a high portion of the Sierra Nevada, this ice-ridden region exhibits a characteristic glacial topography which was developed by repeated alpine glaciations during the Pleistocene. The advances of ice merely modified a previously established topography developed by a long period of pre-glacial stream erosion. Post-glacial erosion has been slight. The region thus presents profound glacial features such as rugged, high, and sinuous mountain crests characterized by sharp ridges, peaks, and minarets with glacial cirques, benches, and hanging valleys overlooking deep U-shaped river canyons. Besides the major topographic features due to stream and glacial erosion, there are minor features due to volcanic activity such as cinder cones and remnant lava plateaus.

Several peaks in the region reach elevations in excess of 12,000 feet and offer commanding views of the surrounding country. The extreme rugged nature of the region gives differences in elevation in short horizontal distances. The lowest point, within the area covered, is on the North Fork of San Joaquin River at about 6000 feet elevation. Mt. Ritter, which is about nine miles to the north, is the highest point with an elevation of 13,156 feet. The average elevation is eight to nine thousand feet.

Three mountain crests form the two drainage basins of the region which, from east to west, are the main Sierra Nevada Crest, the Ritter Range, and the San Joaquin-Merced divide. The former two embrace the basin of Middle Fork of San Joaquin River, while the two latter embrace the North Fork basin of the same river. The three divides converge just south of Mt. Lyell where they form a single prominent crest. The river canyons and mountain crests are developed largely in the area of metamorphic rocks and their trends are determined by the strike of these rocks. The prominent topographic features to which this especially applies includes the Sierra Nevada Crest, Middle Fork River Canyon, Ritter Range, and the North Fork River Canyon.

THE SIERRA CREST

In this section, the Sierra Nevada Crest varies considerably in character. Between Mammoth Mountain and Agnew Pass it is not so rugged and lofty as found elsewhere along the range. Although the elevation is the average for this portion of the Sierra Nevadan fault block, it is dwarfed to comparative insignificance by the loftier and more rugged Ritter Range which stands to the west. The general abruptness of the east slope of the crest is lost, owing to the building up of volcanic flows and pumice accumulations which tend to produce a long even slope towards the Mono Basin. The relatively lower portion of the crest trends in a north-northwesterly direction and includes from south to north, Mammoth Crest (11,000 ft.), Mammoth Pass

(9,350 ft.), Mammoth Mountain (11,934 ft.), Minaret Summit (9,250 ft.), San Joaquin Mt. (11,584 ft.), and Agnew Pass (9,946 ft.). In the vicinity of Agnew Pass the crest swings in a westerly direction to Davis Mountain (12,308 ft.) and thence in a northwesterly direction to Mt. Lyell (13,090 ft.). Beyond the lava-capped portion which terminates at Agnew Pass, the crest becomes increasingly loftier, more rugged, and of more symmetrical development than to the south.

THE RITTER RANGE

The Ritter Range forms a subsidiary spur branching off the main crest of the Sierra Nevada and is the most dominant and imposing mountain range in the region. Rising in a series of serrated and lofty snow-laden peaks, it commands attention and admiration from every angle. Beginning with Davis Mountain, Ritter Range trends in a south-southeasterly direction to Iron Mountain and forms the divide between the North and Middle Fork watersheds. Mt. Ritter is the highest peak with an elevation of 13,156 feet, while Banner Peak, to the north of Mt. Ritter, is second in height with an elevation of 12,957 feet. South along the range are the Minarets with an elevation of 12,278 feet and Iron Mountain, 11,157 feet elevation. Because of the high average elevation of the range, the cirques harbor several small glaciers which are the present day remnants of once great bodies of ice. The glaciers on the flanks of Mt. Ritter and the Minarets are the most notable in the region. The range crest-line, which is generally symmetrical in cross-section, is tortuous and composed of a series of sharp ridges and peaks. The summits generally form steep series of cliffs which plunge rapidly into cirques below and these merge into hanging valleys in a successive step-like profile towards the main

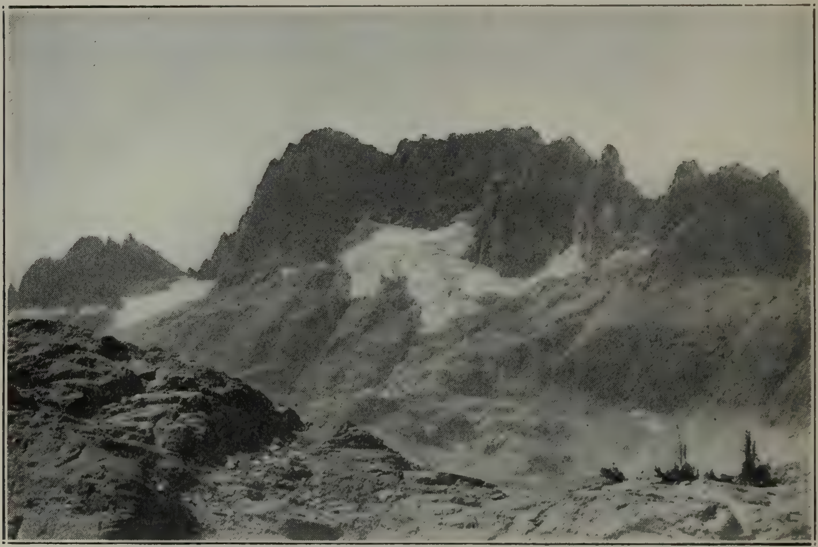

FIG. 3. East face of the Minarets as seen from head of Shadow Creek. Note crevasses in glacier.

Photo by Walter W. Bradley.

canyons. The intervening divides between the hanging valleys vary from comparatively low ice-ridden ridges to prominent and rugged crests, trending approximately normal to the axis of the range proper.

THE SAN JOAQUIN-MERCED DIVIDE

This crest forms the divide between North Fork of San Joaquin River and South and Middle Forks of Merced River. It is a typical Sierran crest as it has been glacially carved in prevailing granite. Branching off of the Sierra Crest just south of Mt. Lyell, the divide trends in a general southwesterly direction. As is characteristic of glacially sculptured mountains, it is comparatively rugged with a sinuous crest which averages quite high in elevation. The highest point along the divide is Rogers Peak with an elevation of 13,050 feet, while other peaks and passes range between 10,000 and 12,500 feet in elevation. The range is rather symmetrical as seen from points on the divide.

THE RIVER CANYONS

The canyons of North and Middle Forks of San Joaquin River are typically glaciated gorges in the Minaret region and they vary in cross-sectional profile from a shallow U-shape to a somewhat deep semi-U-shape. The former is characteristic of the higher levels while the latter is found at lower levels along the river courses. Generally, the walls of the canyons are very steep and occasionally form bold promontories rising from several hundred to over a thousand feet above the rivers. Above the canyon rims, a sort of tableland or bench extends back which gradually rises toward the mountain summits. The tributary streams drain essentially at right angles to the main streams in the metamorphic areas. The hanging valleys, occupied by these streams, form notches in the canyon walls, which are of various depths.

Climate and Vegetation

The climatic conditions of this section are characteristic of the High Sierra. There is quite a marked difference in the seasons during the year, including a well-defined wet or winter season and a dry or summer season. The higher elevations receive most of the precipitation in the form of snow which usually appears in the latter part of October and continues at intervals through the winter until April or May. Occasionally a light snow may fall as late as June or as early as September. The months of December and January probably contribute the greatest amount of snowfall. Snow normally accumulates to a depth of thirty to forty feet in higher parts of the range and exceptional winters have recorded depths in excess of these. Enough snow accumulates and remains from one winter to the next to perpetuate, in favorable situations, a few small glaciers but indications in recent years show that they are gradually disappearing. Although a region of great snowfall, the High Sierra is not perpetually snow-covered, for the summer portion of the year brings a dearth in precipitation. Thunderstorms, accompanied by much lightning with little rain, are common in the late summer months. Generally the winter months are moderately cold and wet, while the summers are moderately warm and dry. Sunshine is abundant in the summer, while much cloudiness prevails in the winter. The wind movement is usually light except in high exposed basins, and on ridges or peaks where increased wind velocities are common daily.

Locally, Ritter Range is a climate maker in the region. As it stands west of the Sierra Crest and is higher, it controls the condensation of the moisture carried by the prevailing winds out of the west and hence makes a more arid state of conditions to the east. This fact is well shown by the nature of the vegetation along the upper east side of Middle Fork Canyon of San Joaquin River.

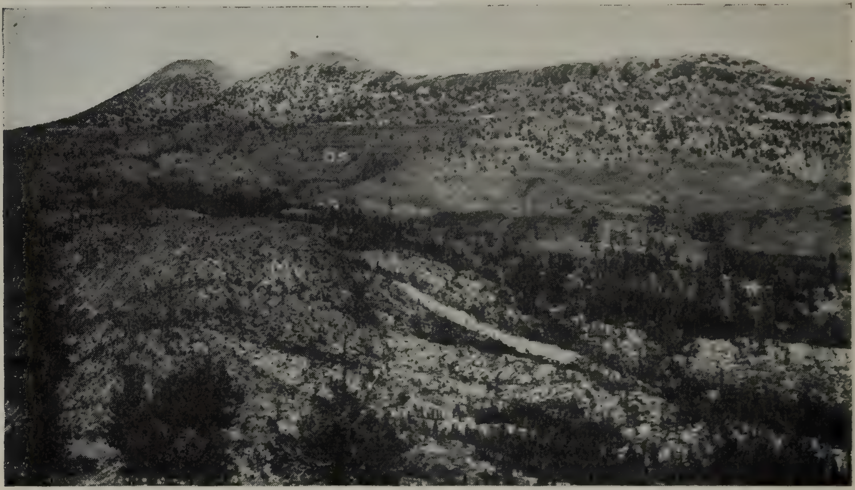

FIG. 4. East slope of Middle Fork canyon and Sierra Crest north of Agnew Meadows as seen from west wall of canyon. San Joaquin Mountain lies to the extreme left with Two Teats immediately to right. D—dike, Mv—metamorphosed volcanics, Sl—slate, Ba—basalt, An—andesite.

Four life zones are represented in the general region: Transition, Canadian, Hudsonian, and Arctic-Alpine, ranging in elevation from 5500 ft. to 13,000 ft. Conifers, such as pines, hemlocks, firs, cedar, and juniper, are the most abundant trees. Among the more important species of these families are the western white pine, white bark pine, western yellow pine, jeffery pine, lodgepole pine, red fir, white fir, mountain hemlock, incense cedar, and the western juniper. There are no economic stands of pine timber to be found in the upper basins of the North and Middle Forks of San Joaquin River.

Besides the conifers, various types of broad-leaf trees are represented, each by one or more species. These include the willow, aspen, chinquapin, and maple. Flowering plants and grasses abound where sufficient soil exists for their support, as in meadowland and along streams. Locally, arid types of vegetation occur regardless of high elevations.

Drainage and Water-Supply

The Minaret region of northeastern Madera County is drained essentially by the North and Middle Forks of San Joaquin River which rise here. Beginning in the north, they flow in a general southeasterly direction, changing to a southern and then to a southwestern course, joining the South Fork of San Joaquin River, which drains towards the west. The direction of flow of the two upper forks is due to structural control afforded by the folded metamorphic rocks, the strike of which is ordinarily northwest to north-northwest. The main streams flow parallel to the structural folds, while the tributaries are discordant and flow across the upturned edges of the rocks.

A prolific supply of water is afforded by San Joaquin River and its tributaries.[2] This is due to the large snow fields together with the glaciers that exist throughout the summer months. A continuous flow is maintained by the abundance of glacial lakes which impound the water throughout the drainage systems.

Besides a number of cold-water springs, there are several carbonate and hot springs.[3] Of the carbonate springs, those at Soda Springs Meadow, Pumice Flat, and Sheep Crossing are the most important, while Reds Meadow and Fish Valley offer the only hot springs.

DESCRIPTIONS OF GEOLOGICAL FORMATIONS

The Minaret District includes an attached roof-pendant of highly-folded metamorphic rocks which have been intruded by granites and in part overlain by much later volcanic materials. Long continued uplift and erosion removed most of the original rock-cover, leaving the roof-pendant of the Minaret region as a remnant.

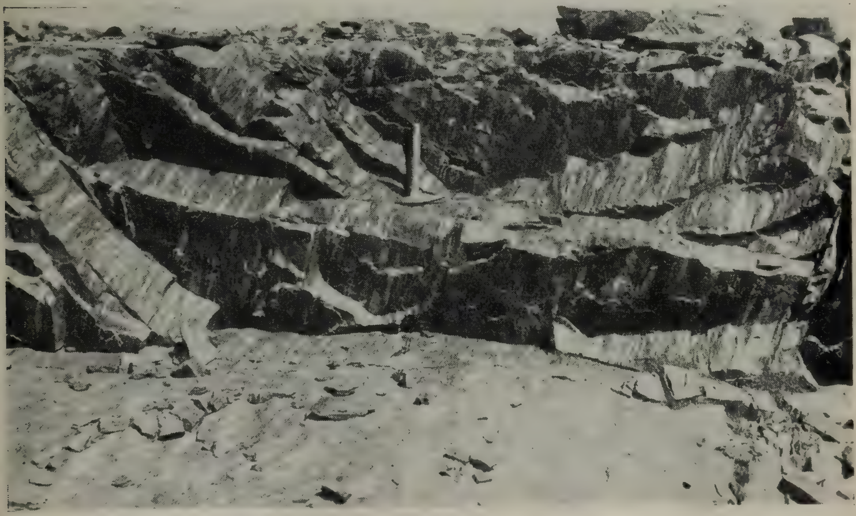

FIG. 5. Augen-structure developed from a volcanic lithic tuff.

The members of this series strike in a general northwestern direction and dip steeply to the southwest. They occupy essentially the upper Middle and North Fork Basins of San Joaquin River. The age of the metamorphic rocks is probably Mesozoic, upper Triassic to possibly lower Jurassic.

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[2] U. S. Geol. Survey Water-Supply Papers 551, 611, and 631.
[3] U. S. Geol. Survey Water-Supply Paper 338, pp. 55–56, 238–239, 1915.

The age of the intrusive rocks is regarded as late Jurassic or early Cretaceous. These intrusives not only surround areas of metamorphic rocks but also occur as stocks within these areas.

Upon the eroded surface of the granitic and metamorphic rocks, later volcanic rocks have been deposited. These are found largely in the eastern part of Middle Fork basin. There are two groups of flows of which the earlier is considered late Miocene in age, while the latter is Pleistocene. Glacial till, stream material, and pumice constitute the most recent deposits.

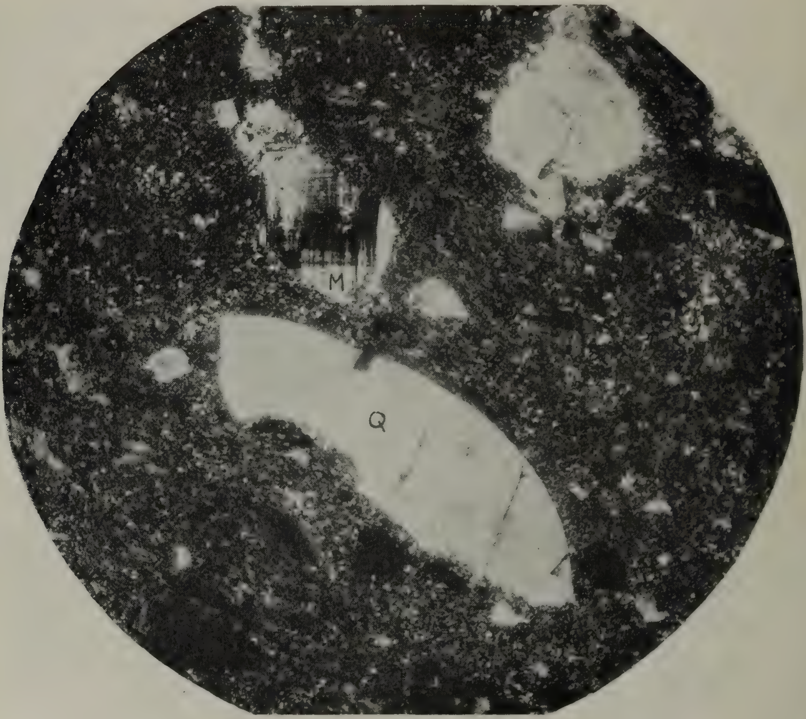

Fig. 6. Thin section of metamorphosed crystal-vitric rhyolitic tuff. M—microcline. Q—quartz. This rock is composed of mineral fragments of above minerals in a finer recrystallized matrix of similar material. 50 diam. x-nicols.

Metamorphic Rocks

The oldest and most important rocks of the Minaret region are the metamorphics, since they constitute a pendant which has served as a host to mineralization, resulting from granitic invasion. They consist essentially of metamorphosed volcanic tuffs and flows together with intercalated limestone and slate. The volcanic rocks were originally rhyolitic, latitic, dacitic, andesitic, and basaltic in composition, and make up by far the greater part of the entire metamorphic group. Of these, the pyroclastic materials are the most abundant.

Orogenic forces folded and subjected the rocks to cataclastic and dynamic metamorphism following their accumulation in a marine environment during upper Triassic and lower Jurassic time. As a result, the volcanic rocks were altered chiefly into mylonitic types consisting of meta-tuffs and flows while other members were more completely altered into various schistose types. The more basic rocks suffered the greatest mineral alteration. The slate resulted from the dynamic alteration of clay-rich sediment, while the original limestone was marbleized. Generally the rocks have suffered little mineral alteration as the result of igneous intrusion which followed close after the folding. Epidote is commonly developed in most of the metamorphics, as well as in the earlier intrusive rocks.

The different members of the group are not uniform in appearance along the strike of the surface outcrop. This is attributed to difference in original composition and to various degrees of metamorphism. For the purpose of discussion, the metamorphic rocks will be classified as undifferentiated meta-volcanic rocks, limestone, and slate.

UNDIFFERENTIATED META-VOLCANIC ROCKS

Middle Fork Basin.—This group includes the metamorphic rocks of volcanic derivation which occur in the Middle Fork Basin between Ritter Range and the Sierra Crest.

The meta-volcanic rocks, which form the bulk of the east wall of Middle Fork Canyon, are light brown to gray in color, somewhat schistose, and generally exhibit a relict clastic or porphyritic texture. North of Agnew Meadows, the rock is generally a light-brown to gray-spotted schistose rock composed of quartz fragments in a finely-crushed matrix of quartz, oligoclase, and sericite. In places it appears to be entirely a quartz-sericite schist. Pyrite is disseminated through the rock and has been altered to iron oxides giving a brownish color to rocks of this vicinity. The original rocks were largely rather acid

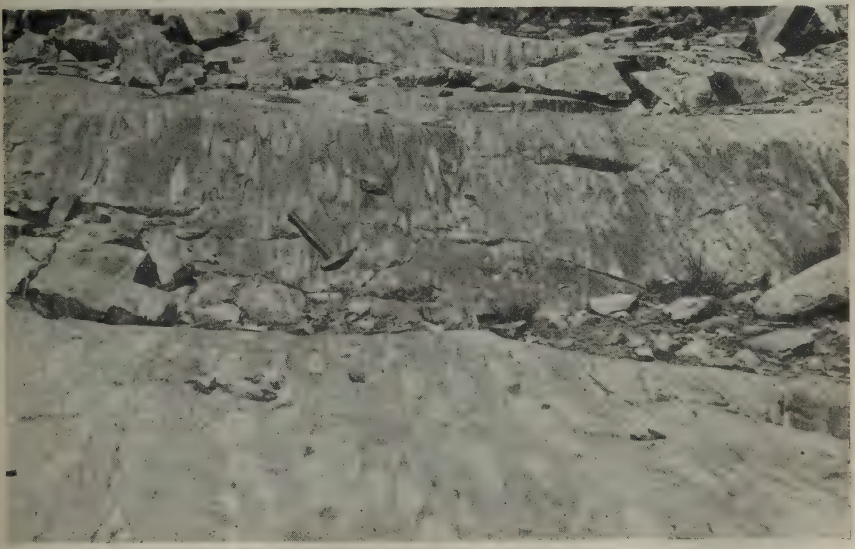

FIG. 7. Nodular rhyolite lava flow of probable submarine origin.

lavas, such as rhyolite or quartz porphyry and the present large mineral fragments are surviving phenocrysts giving a blastoporphyritic rock as a result of metamorphism. Some of the rock is largely of pyroclastic origin as a pronounced clastic structure is preserved. This phase was probably derived from a crystal-lithic tuff.

Directly northwest of the upper end of Agnew Meadows, there is a prominent light-colored dike-like body interstratified with the light brown meta-pyroclastic rocks in that vicinity. Although the body appears to be a dike, it is apparently not of igneous origin, but instead, an interbedded lenticular mass. It has a maximum width of about 50 feet and a surface outcrop of about 2500 feet. Owing to its exceedingly hard and dense nature, it has been far more resistant to erosion than adjacent wall rock and thus forms a wall-like body which ranges in height up to 50 feet. The strike is concordant with the schistosity of the metamorphic rocks. It is a fine to medium-grained crystalline rock, composed of angular fragments of quartz and andalusite which lie in a micro-crystalline matrix of the same minerals.

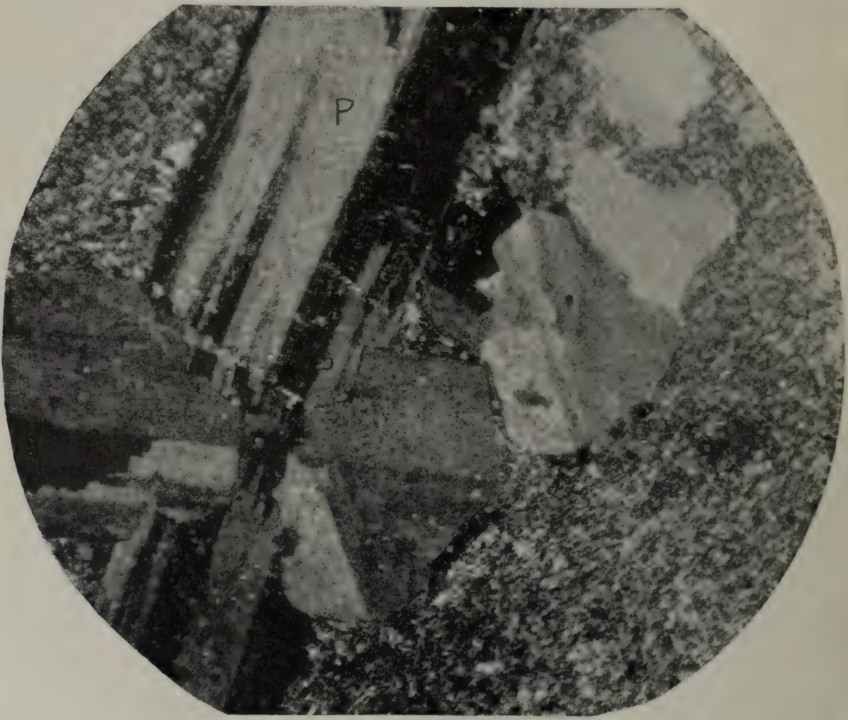

FIG. 8. Thin section of metamorphosed dacitic crystal-vitric tuff of the Ritter volcanics. The rock consists of oligoclase (P), fragments in a finely recrystallized matrix composed of quartz, feldspar, biotite, hornblende, magnetite, spilosite, sericite, and epidote. 60 diam. x-nicols.

Immediately south of Agnew Meadows, the metamorphic rock is black, shows a distinct relict-porphyritic texture and is composed of blasto-phenocrysts of andesine and quartz in a dark finely crystalline matrix of quartz, feldspar, biotite, augite, sericite, magnetite, zircon, and epidote. Some of the feldspar phenocrysts are euhedral in form, 4 or 5 mm. in length. The quartz crystals are usually broken and show that they had been strained. Under the microscope, the groundmass is somewhat schistose. The rock was probably a dacite flow and is now designated as a meta-dacite. In direct association with this rock is a dark-gray schist which shows a relict-porphyritic texture with approximately the same composition, but it has been subjected to a greater degree of dynamic alteration.

In the upper basin of Middle Fork of San Joaquin River along the Rush Creek divide, the metamorphic rocks vary considerably across the strike. West of the lava-capping in Agnew Pass, for about $\frac{3}{5}$ of a mile, occurs a dark-green biotite schist, which retains in part a relict-porphyritic or clastic texture. It was probably derived from a rather basic tuff or flow. Farther to the west at the outlet of Thousand Island Lake, the metamorphic rocks commonly show a streaky, banded, or augen-structure due to the crushing and drawing out of fragments which were originally of a lithic tuff or volcanic breccia. In places, the fragmentary state of the rock is well preserved, but these structures are absent 1½ miles south of the divide. Various light-gray, green, and purplish-black schists and slates of volcanic origin are common in the group of meta-clastic and blastoporphyritic rocks. One member

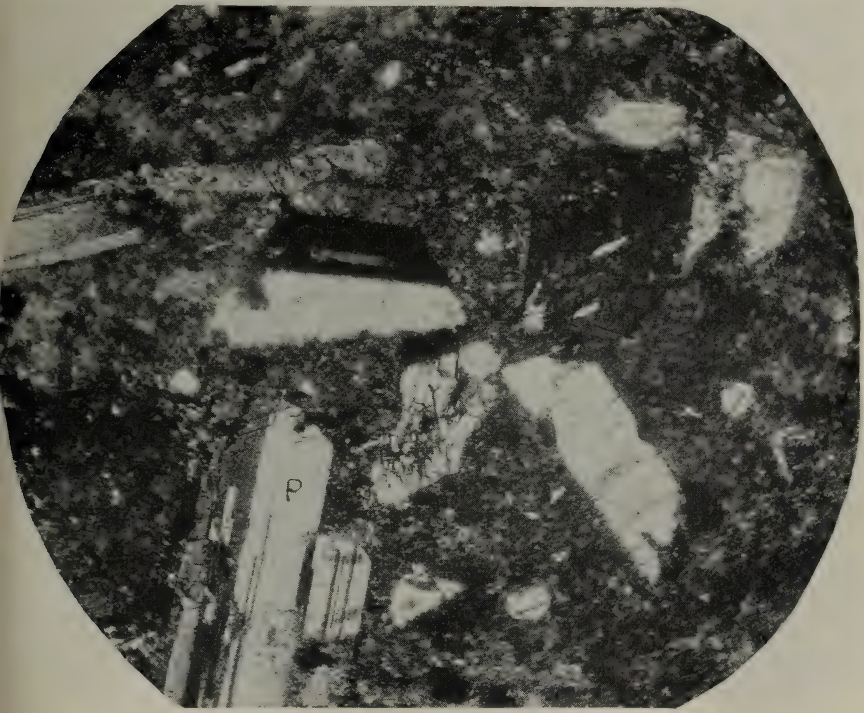

FIG. 9. Thin section of metamorphosed andesitic crystal tuff of the Ritter volcanics. P—plagioclase feldspar (andesine). The feldspar occurs as fragments in a schistose matrix of hornblende, biotite, and magnetite. 60 diam. x-nicols.

included a black, spotted schist composed of clusters of biotite flakes up to 4 or 5 mm. in diameter, scattered through a matrix of quartz, plagioclase feldspar, and biotite. Another member consists of a light-gray-spotted schist composed of blasto-phenocrysts of quartz and feldspar in a matrix of quartz, feldspar, biotite, and sericite. Epidote occurs abundantly through the rock as irregular patches and in veinlets with quartz. On the Rush Creek divide, just west of Agnew Pass, small aplitic dikes are found conforming with the strike, which carry epidote and large platy masses of ilmenite.

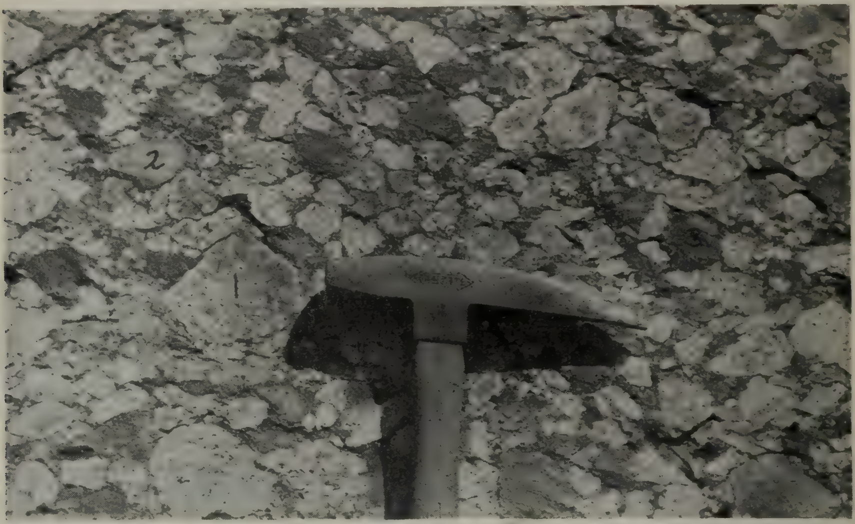

FIG. 10. Meta-lithic tuff of the Ritter volcanics. Note various kinds and sizes of angular fragments in matrix of finer material. (1) light gray meta-dacitic crystal tuff; (2) dark gray tuff of same type.

On the west side of Middle Fork of San Joaquin River various colored units of metamorphic rocks alternate in parallel bands, and strike across the ridges and hanging valleys in a northwesterly direction. On the trail between the river and the outlet of Shadow Lake, the variations in these rocks are well shown. Among the most important types are various schists and mylonitic rocks. Lowest in the group is an olive-gray knotted schist composed of patches of biotite and hornblende in a matrix of quartz, sericite, hornblende, biotite, and magnetite which was probably derived from a basic volcanic tuff.

Another type, occurring in three distinct members, can be seen on the west canyon wall for some distance, because of its distinct pinkish color. It is reddish gray to almost black, with a knotty schistose texture. Relict mineral fragments appear in the rock as white spots scattered through the matrix. The formation is apparently an old dacitic flow, composed of remnant phenocrysts of quartz, orthoclase, oligoclase, and andesine with a matrix of sericite, biotite, and epidote. Piedmontite has also been reported.[4] Immediately below the outlet of Shadow Lake is a greenish-black epidote schist closely associated with the pink rock, and composed of an abundance of epidote which forms large aggregates in a dark matrix of feldspar, sericite, and epidote. This rock was probably derived from a basic flow. Between the river and the outlet of Garnet Lake, the rocks are of about the same composition as below Shadow Lake but contain much more epidote. A short distance north of Garnet Creek, the narrowing units of meta-clastic rocks, from the north, grade into the above types along the general strike. The pink members change generally in color to darker tones in the vicinity of Garnet Creek. The lower member continues as a pink schist for about a half mile north of Garnet Creek in the canyon of Upper Middle Fork. Under the microscope, this rock was found to be composed of common epidote, withamite, tremolite, and quartzose material.

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[4] Mayo, Evans B., Two new occurrences of piedmontite in California: Am. Mineralogist, vol. 17, pp. 238–248, 1932.

————————, Discovery of piedmontite in the Sierra Nevada: California State Div. of Mines, Rept. XXIX, pp. 239–243, 1933.

Extending from Garnet Creek, south to the granite of the Minaret-Shadow Creek divide, is a very light-colored rock which stands in marked contrast to darker types. A specimen, taken near the outlet of Garnet Lake, shows a light-gray, medium-grained porphyroclastic rock composed of fragments of orthoclase, quartz, oligoclase, in a somewhat schistose groundmass of finely crystalline quartz, sericite, biotite, and magnetite. The darker minerals are rare. From the general mineral assemblage, the rock appears to have been derived from a dacitic crystal tuff. On the Shadow Creek-Garnet Lake divide, near the granite mass, the same rock member appears to have been derived from a rhyolitic crystal-vitric tuff. This member is bounded in part by strike faults and tends to form a trough-like basin along which several lakes are situated. A second prominent occurrence of this rock is found midway between Ritter Range and Middle Fork, between

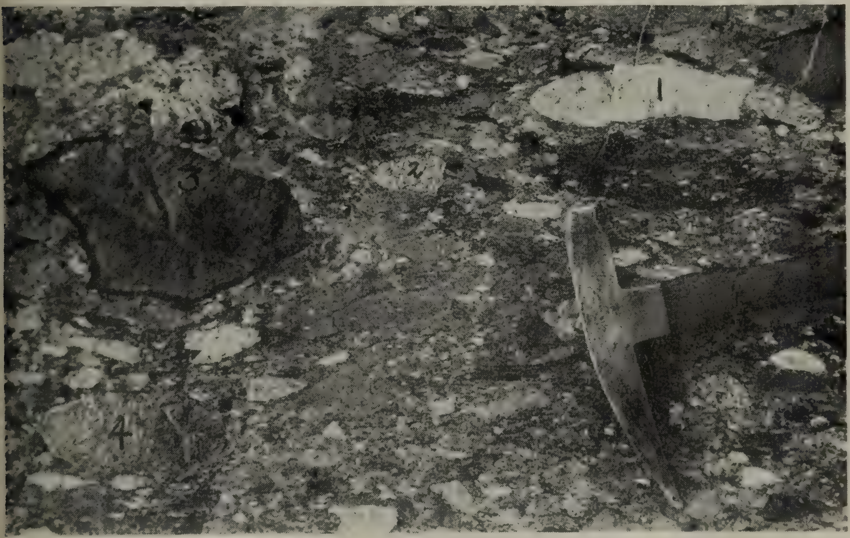

FIG. 11. A similar type of rock as in Fig. 10 but has been subject to greater degree of metamorphism. The fragments have been oriented in direction of least pressure and drawn out. (1) and (2) as in Fig. 10, (3) meta-andesite flow, (4) meta-dacitic flow, (5) biotite schist.

the Garnet-Shadow Creek divide south to the north wall of Minaret creek on Volcanic Ridge. It is rather irregular and consists of several units which taper and coalesce into one another towards the south. The rock was derived from a rhyolitic crystal-vitric tuff. In the vicinity of Garnet Lake it is difficult to distinguish this rock from border phases of the closely associated intrusive rock and it is probable that some of the area mapped as granitic rock includes some of the light meta-tuff. The same condition is probably true of certain portions of the light-colored granite north of Thousand Island Lake and especially in the western portion of that body.

Between the two lighter-colored rock members south of Garnet Lake, the metamorphic rock consists of the dark meta-volcanic rocks of porphyroclasts and blasto-porphyries. One specimen taken just south of the outlet of Garnet Lake was a nearly perfectly preserved andesitic lava. Usually, however, the rocks are at least crushed or mylonitized. Small limestone members are interbedded with the meta-volcanic rocks, but are of minor importance.

Between the outlet of Thousand Island Lake and the western contact of the granite, an interesting assemblage of metamorphic rocks exist which have little continuation to the south beyond the north shore of Garnet Lake. At the lower end of Thousand Island Lake there is a prominent black slate-like rock which, under the microscope, is essentially a biotite schist containing a small amount of feldspathic material and magnetite. This rock is believed to have been derived from a water-laid basic volcanic tuff. In contact with the schist, to the west, is a rock which appears to have been originally a submarine flow because of its well-preserved nodular structure. The rock is generally light-gray with a spotted appearance, due to the development of bunches, two or three millimeters in diameter, of incipient mica flakes scattered through a quartzose-feldspathic matrix which is host to a swarm of nodular or ellipsoidal forms exhibiting a similar composition. These nodular forms are believed to be due to the under-water cooling of an originally acid lava flow. They vary from several inches up to several feet in length and are generally three to four times longer than they are wide. Towards the west the rock becomes darker owing to an increase in biotite and the nodules become fewer. This unit is in contact with a prominent limestone member which in turn is in fault-contact with the granite and hybrid portions of that rock. Within the assemblage to the north of Thousand Island Lake are various mylonitic and schistose rocks.

The balance of the metamorphic rocks, in the Middle Fork basin, exclusive of the Ritter Group, includes the larger group of metamorphosed lavas and tuffs of acid and intermediate composition, with a gray or dark appearance. This includes the metamorphic rocks in the basins of Shadow and Minaret Creeks. A piedmontite schist has been described as occurring at the summit of the eastern end of Volcanic Ridge.[5] Interbedded with these rocks are limestone members.

Ritter Range.—The rocks of the Ritter Range embrace an area which is bounded roughly on the east by the diorite porphyry and other intrusive masses and on the west approximately by the North Fork of San Joaquin River. In the field, the rocks thus grouped generally have a bluish-gray to dark color, massive appearance and show little metamorphism beyond that of a normal cataclastic type. They probably were originally dacitic and andesitic tuffs and flows, including some rhyolitic materials.

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[5] **Mayo, E. B.,** ***Op. cit.***

The rock which composes the peaks and crest of the Ritter Range from Banner Peak south to Iron Mountain is of a dense, black-appearing, uniformly-spotted type. It is very hard and commonly breaks with a conchoidal fracture. The white spots are apparently remnant phenoclasts, set in a recrystallized matrix of finer material. These fragmentary bodies exhibit a white or pinkish appearance and often show either albite or carlsbad twinning. In places, small fragments of included quartzose material or rock fragments are to be found. Abundant incipient fractures commonly occur through the rock, which carry quartz and epidote which is also present as irregular masses in the rock and as alteration product after plagioclase feldspar. Specimens taken from the summits of Mt. Ritter, the Minarets, and the head of Minaret Creek, King Creek, and Iron Creek, show a very similar appearance in the hand specimen, as well as under the microscope. Texturally, the rocks are porphyroclastic; the phenoclasts are usually of oligoclase or andesine feldspar, and the matrix is of recrystallized quartzose-feldspathic material containing a small amount of biotite, magnetite, sericite, and epidote. In some specimens hornblende and spilosite are present. Indications of devitrification were noticed in two specimens which suggest that the matrix may have been derived largely by crystallization of volcanic glass. The tuffs are represented by vitric, crystal, and lithic varieties. At the southern end of the range an admixture of andesitic material occurs along with what was originally dacitic. A specimen taken from the divide at the head of the North Fork of King Creek showed a distinct dark schistose rock which, microscopically, contained phenoclasts of andesine feldspar in a finely-crystalline matrix of feldspathic material together with biotite, hornblende, and magnetite. In the upper reaches of Iron Mountain is a dark blasto-porphyritic rock composed of remnant oligoclase-andesine feldspar phenocrysts with a micro-crystalline matrix of feldspar, biotite, hornblende, magnetite, sericite, and epidote. This rock was probably derived from an andesitic lava flow. Some of the old basic flows are preserved to the extent that the original vesicularity of the rock can be recognized. In most cases the vesicles have been crushed or filled with later mineral matter. Epidote, quartz, and calcite are among the chief minerals to fill the vesicles.

On the summit of Sentinel Peak (11,115 ft.) is a well-preserved andesitic rock. A specimen was taken of a dark porphyritic rock of rather acid composition on the west slope of Mt. Ritter. A relict of the original igneous texture is well preserved in it. It is composed of remnant phenocrysts of orthoclase and oligoclase feldspars set in a matrix of micro-crystalline quartz, feldspar, and a little biotite or hornblende. The rock appears to have been derived from a quartz latite-dacite flow. On the west side of the Ritter Range the rock assemblage is generally more fragmental in structure. In this phase angular fragments of volcanic materials range from fine dust to blocks weighing many tons, set in a matrix of finer material. The fragments are composed essentially of dacitic and rhyolitic tuffs and dacitic andesitic flow rock. The matrix is generally composed of fine fragments, quartzose-feldspathic material, biotite, magnetite, sericite, and devitrified glass. In some cases the larger fragments are abundant and compact, while in other cases they are fewer and farther apart. Extreme dynamic forces have in many cases crushed and drawn out the larger fragments, giving a somewhat augen structure. Interbedded with the predominant volcanic fragmental rock of North Fork basin are various other rock types as already described, such as meta-rhyolitic and dacitic crystal tuffs and dark-gray or black slaty and schistose rocks, also of tuffaceous origin.

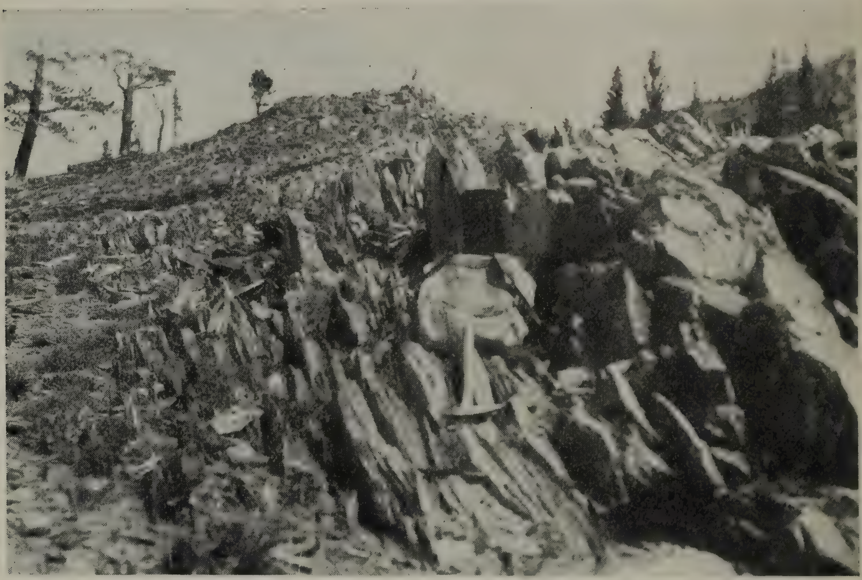

FIG. 12. Argillaceous slate which outcrops northeast of Agnew Meadows.

North Fork Basin.—Between the granite and the North Fork of San Joaquin River the metamorphic rocks present a higher grade of metamorphism than the Ritter Group. These have been subjected to igneous intrusion and dynamic action which has resulted in mylonitized and schistose types. They are largely of volcanic derivation and include some original interbedded sediment.

The rock in the vicinity of Lily Lake is largely a meta-rhyolitic crystal tuff. A coarse variety contains fragments which have been drawn out to an augen structure. In the vicinity of the junction of Dike Creek and the North Fork, the rock is a dark-gray biotite schist. West of North Fork the schistose rocks grade into meta-tuffs of acid to intermediate composition and have in the field a general black to light-gray appearance. Immediately east of the river, above the Dike Creek junction, there is a prominent strike ridge of light rock which forms the hanging wall of a large fault which parallels the river. The rock is light brown to gray in color, generally schistose, and composed essentially of quartz and sericite. An important variation in the rock is found about half a mile below the junction of Bench Creek where the rock is a bright purplish green schist composed of crystals of andalusite up to a centimeter in length in a matrix of muscovite.

Pyrophyllite is an important constituent in the vicinity of a low pass immediately east of the Bench Creek and river junction. The mineral is well developed in large radiated masses along with large prismatic quartz crystals and tabular masses of ilmenite which line the walls of veins in essentially a pyrophyllite schist.

In the upper North Fork Canyon there are admixtures of quartzite and slate, the meta-volcanic rocks, and near the western contact, just south of Bench Creek, limestone and conglomerate occur.

META-SEDIMENTARY ROCKS

Slate.—Extending in a north-northwest direction from Agnew Meadows is an important slate member which has been mapped as a separate unit. It is generally a black appearing rock, of uniform composition and presents a highly-developed slaty cleavage. Locally, portions of the rock are phyllite or mica schist. Under the microscope, the slate is composed of finely-crystalline quartzose and micaceous material, together with graphitic matter. Small cubes of pyrite are disseminated through the slate which have weathered to give a light iron staining. Interbedded with the slate are several lenticular bodies of dark-grey, fine-grained quartzite, and light-brownish colored meta-rhyolitic tuff. Numerous quartz veinlets are commonly present near

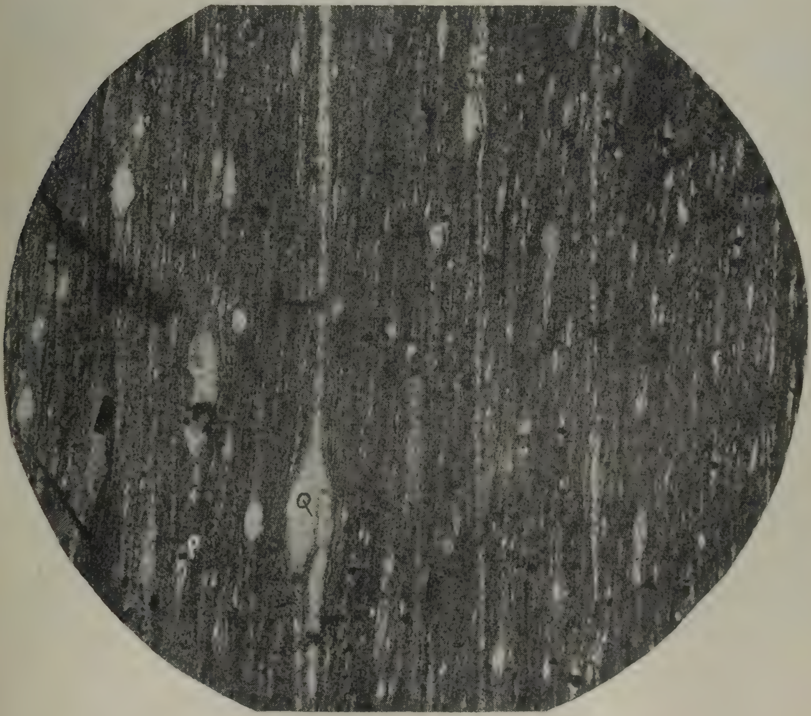

FIG. 13. Thin section of slate showing rolled fragments of quartz in a dark graphitic matrix (Q). P—pyrite. 60 diam. Ordinary light.

these bodies and carry pyrite. The slate was derived from the dynamic metamorphism of a water-laid, clay-rick sediment which originally contained much carbonaceous matter.

Intercalated with the main meta-volcanic assemblage are occasional members of slaty rock which are apparently of clay origin. Among the most important of these are several members which occur along the west wall of upper North Fork Canyon south of Rogers Peak. The rock is generally quite similar in every respect to the slate of Middle Fork basin but apparently of different age.

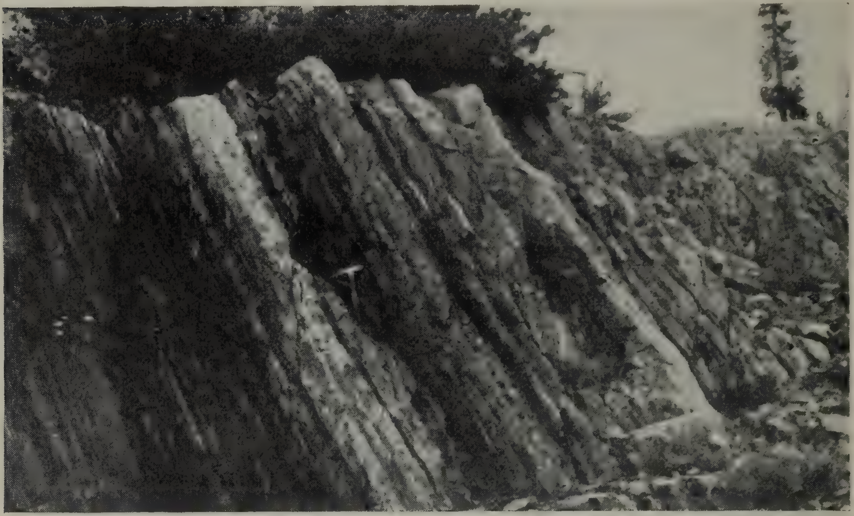

FIG. 14. Crystalline limestone with original bedding and parting structure preserved.

Limestone.—The limestone members, which are usually marbleized, are among the most important rocks of the entire region, as they are economically mineralized in places. The most important occurrences consist of several members which are interbedded with the meta-volcanic assemblage of the San Joaquin basin between the Ritter Range and the Middle Fork River. Other members are quite discontinuous and do not extend for any great distance without thinning out.

'Mother Lode' Limestone.—The most important of the several limestone members which is host to the mineralization in Minaret and Shadow Creek basins is locally known as the 'Mother Lode' limestone. This member outcrops from the south shore of Thousand Island Lake to a point about five miles south where it is cut out by the granite in Minaret Creek basin. It varies from 300 to 500 feet in width throughout this outcrop. The original rock has undergone considerable change in places and it is difficult to recognize. This is especially true to the north where the granitic rock has intruded and greatly affected the limestone. The less-altered portions of limestone show a pronounced bedding structure with beds of marble or silicified limestone ranging up to three inches or more in thickness, alternating with relatively less-altered lime or arenaceous lime material which makes a parting ranging up to an inch or more in thickness. As such, the rock may be whitish or light-gray

in color but more generally it is light to dark chocolate-brown, due to the various degrees of iron staining. A distinct brown appearance is also due to the abundant development of grossularite in the limestone. Light-green or blue colors are commonly due to the moderate development of diopside and epidote. Where the alteration has been more complete, the limestone may present a color which is characteristic of any one or all of the resulting minerals which may be light-green epidote, diopside, brown garnet, or dark-green actinolite.

In the more completely altered portions, the development of silicate minerals is extremely high with a nearly total obliteration of original structures. This is especially true of larger xenolithic inclusions in the granite in the vicinity of Island Pass. Beginning near Thousand Island Lake and extending to the south for about a mile and a half the limestone has been injected, assimilated, and altered by granitic magma to such a degree that it is difficult to recognize the original rock. A primary gneissose structure in the granite together with the alignment of included epidote rock fragments, offer the best evidence as to the original nature of the rock. This condition is readily observed at the head of Garnet Lake. Limy conglomeratic and arenaceous material make up a minor variation in the limestone in places. In the coarser phase, the pebbles are usually not larger than a walnut and show considerable rounding by the action of water.

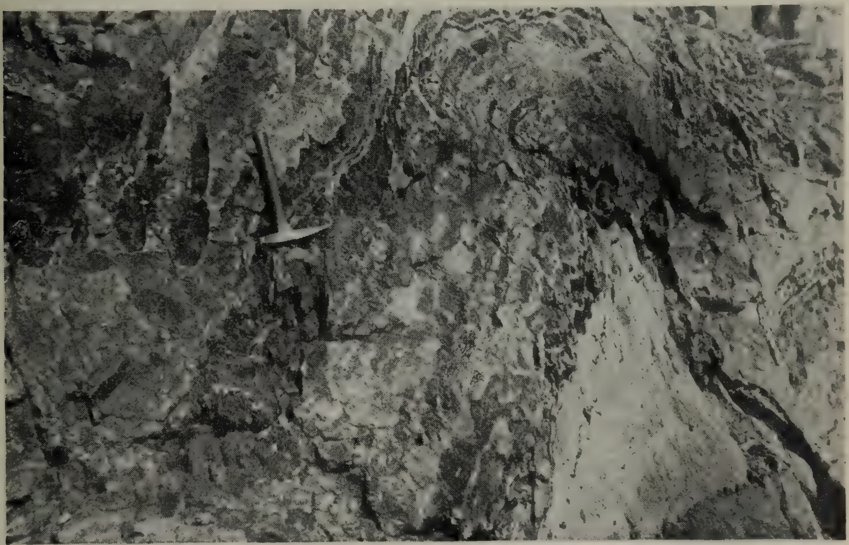

FIG. 15. Highly altered and contorted limestone with original bedding structure nearly obliterated. Epidote and grossularite constitute the most important of the new minerals developed.

Other Limestones. A second limestone member lies immediately east of the mineralized member described above. This one is in close association with the granite and diorite porphyry and is quite a discontinuous member, as it is embayed and is cut out often by the intrusive rocks and does not extend far beyond Shadow Creek to the south.

Other small members of limestone occur east of the 'Mother Lode' limestone, in Middle Fork basin, but are of little importance. These all present the same general character as the limestone elsewhere, excepting that they generally do not show any high degree of alteration.

One large member lies immediately east of the granite in Island Pass and extends south across the lower Thousand Island and Garnet Lakes to the top of the divide just south of Garnet Lake and averages from 200 to 300 feet in width. Several smaller members parallel this member between the Rush Creek and the Shadow Creek divides. Two other units include one which begins on the Garnet Lake-Shadow Creek divide and extends to the top of Minaret-Shadow Creek divide and another begins on the Shadow Creek divide and extends down to Minaret Creek. Both of these are about 100 to 200 feet in width and generally show about the same degree of alteration along their strike. No limestone of any importance occurs in North Fork basin. There is, however, a fragmentary portion of an original limestone on Bench Creek-Long Creek divide.

OUTLYING PENDANTS OF METAMORPHIC ROCKS

Besides small areas of metamorphic rock immediately associated with the contact of major intrusive bodies, there are a few outlying areas of rock somewhat removed from the main pendant. The most prominent of these are to be found on the western divide of North Fork basin. A dark, prominent, narrow body of rock, which crosses the divide just south of Isberg Pass, proved to be a pendant of metamorphic rock. The dark appearance of the rock makes a marked contrast with the lighter granites and can be seen for some distance. One specimen, taken from the eastern end of the body, proved to be a meta-dacitic crystal tuff.

Other large pendants include the black-appearing rocks which compose the upper reaches of Black and Sing Peaks and vicinity. Although these bodies were not investigated, it is quite probable that the rock is also generally of volcanic origin.

AGE OF METAMORPHIC ROCKS

Although there have been found no fossil remains which would indicate a definite age for the metamorphic rocks of the Minaret District, sponge spicules were observed in the slate member north of Agnew Meadows. Certain general relations indicate that the rocks belong to the middle or lower Mesozoic, because they are similar lithologically and present a relative grade of metamorphism which compares closely with rocks found elsewhere in the Sierra Nevada and which are regarded as Triassic or Jurassic in age. Such occurrences include the Mineral King group and the group found at the head of the North Fork of Oak Creek and vicinity.

If the various groups are to be correlated, widespread volcanic materials must have been deposited sufficiently during the same interval to give a great thickness. In this respect it has been pointed out that the Triassic was a period of volcanic activity along the whole Pacific Coast from the southern Sierra Nevada to the Alaska Range.[6]

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[6] Lindgren, W., Igneous Geology of the Cordilleras; Problems of American Geology, pp. 250–252, 1915. Yale University.

In the Inyo Mountains, 4500 feet of andesitic lavas and tuffs overlie limestone of middle Triassic age.[7] The mineral King group of rocks of volcanic and sedimentary origin are regarded as Triassic from fragmentary fossil evidence.[8] It would appear, therefore, that the metamorphic rocks of the Minaret region may be for the most part of Triassic age, though the Jurassic may also be represented.

Igneous Rocks

INTRUSIVE ROCKS

The intrusive igneous rocks of the Minaret region are represented by five major types which form a group ranging from alkali granite to andesine diabase. These are normal types, generally fresh and unaltered. The rocks which constitute the middle position of the group are the most abundant types and compose the main mass of the Sierra Nevada batholith. The remaining types are closely associated bodies of smaller extent which form irregular stock or dike-like bodies and marginal facies. Besides being the result of one general period of igneous intrusion, the rocks have been intruded in an order of increasing silicity. The age of the intrusion is regarded as late Jurassic or lower Cretaceous, as is the Sierra Nevada batholith.

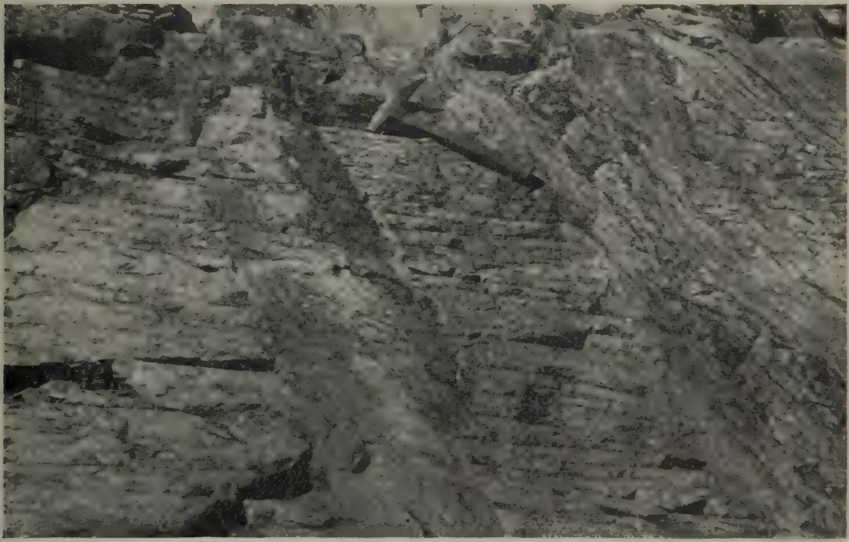

FIG. 16. Granite injected along bedding planes of limestone with nearly complete digestion and removal of original rock. Highly epidotized fragments indicate original nature of rock.

Andesine Diabase.—This rock is the most basic type of the larger intrusive bodies in the Minaret region. It occurs as small irregular and stock-like bodies, principally on the west slope of Iron Mountain and in the upper basin of the North Fork river.

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[7] Knopf, A., and Kirk, E., Geologic reconnaissance of the Inyo Range and the eastern slope of the Sierra Nevada, California: U. S. Geol. Survey Prof. Paper 110, p. 48, 1918.

[8] Knopf, A., and Thelen, P., Sketch of the geology of Mineral King, California: California Univ. Dept. Geology Bull., vol. 4, p. 423, 1905.

It is quite uniform in texture, which is seen best on the weathered surfaces where the plagioclase feldspars stand out in relief, showing a closely interlocking network set in a greenish-black hornblendic groundmass. The feldspars are of andesine and vary in size from 5 mm. to 2 cm. in length and from 2 mm. to over 1 cm. in width and generally exhibit a purplish brown appearance on a fresh surface. The groundmass is composed essentially of medium to coarsely-crystalline well-developed hornblende and biotite with minor amounts of apatite and magnetite. Secondary minerals often include epidote, sericite, penninite, and leucoxene. Commonly, the large feldspar phenocrysts have been fractured along cleavage directions and penetrated by a finer phase of the same material which composes the groundmass. The development of abundant epidote and saussaritized feldspars have been important igneous after-effects in the diabase.

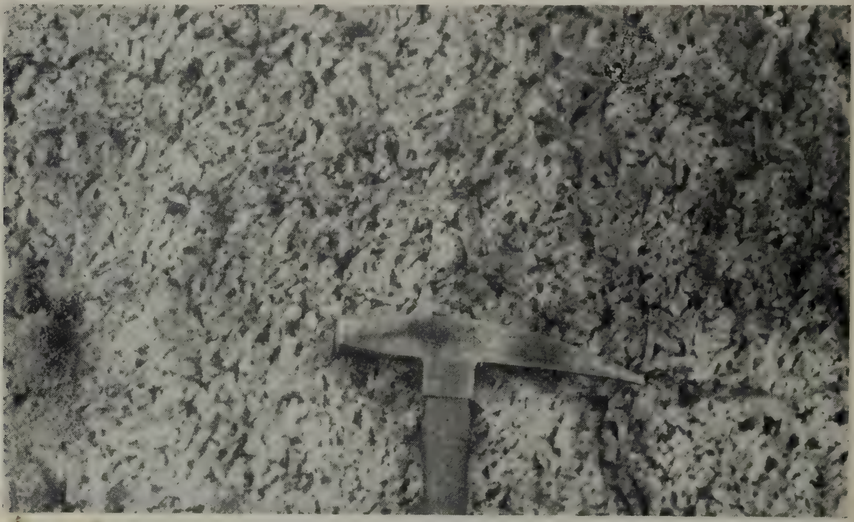

FIG. 17. Andesine-diabase.

In age, the diabase is one of the oldest of the major intrusive rocks. It is itself intruded by diorite on the west slope of Iron Mountain. In the upper basin of the North Fork at Bench Creek, a body of diabase appears to have been intruded between the steeply-dipping members of metamorphic rock.

Diorite Porphyry.—This rock is the most abundant of the more basic types to be found in the Minaret region. The most important occurrences constitute two irregular bodies, located in the Upper Garnet, Shadow, Minaret, King, and Iron Creek basins. In general, the bodies are somewhat elongated in the direction of the strike of the metamorphic rocks. Several smaller bodies of irregular shape occur at various localities in the North Fork Basin as shown on the geologic map. Owing to the inaccessibility of a large part of the area in which the diorite porphyry exists, it is quite possible that much of that mapped includes some metamorphic rock. This is especially true along the crest of the Ritter Range and high on Volcanic Ridge.

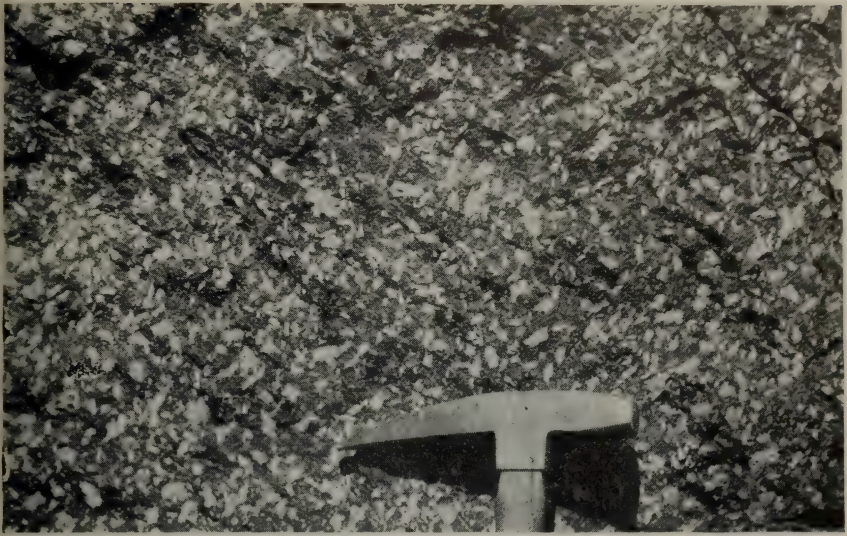

FIG. 18. Diorite porphyry.

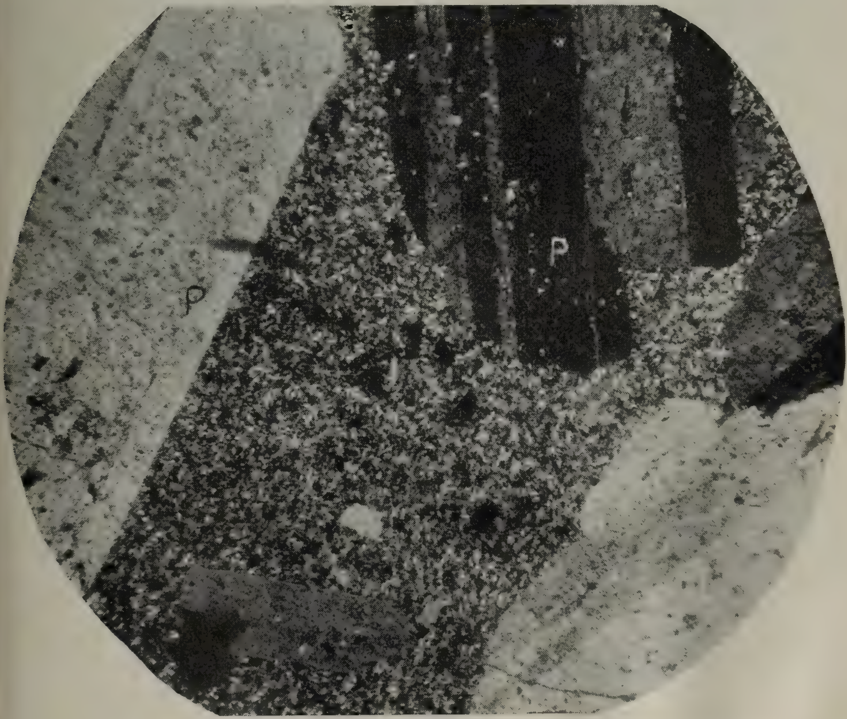

FIG. 19. Thin section of diorite porphyry. P—basic oligoclase feldspar as phenocrysts in a micro-crystalline groundmass of hornblende, biotite oligoclase, magnetite, and apatite. 60 diam. x-nicols.

Throughout the surface outcrops, the rock is quite constant in composition but considerably variable in texture. Although a good part is distinctly porphyritic, the greater bulk of the rock appears to be a rather dense, fine-grained, dark-green variety.

The best development of the porphyritic phase is to be found usually near the contact of the intrusive with the metamorphic rocks. In this phase, the rock is in color dark-green to black, distinctly porphyritic, medium to coarse grained, with well developed crystals of oligoclase in a dense, fine-crystalline greenish-black groundmass composed essentially of hornblende, biotite, oligoclase, magnetite, and apatite. The porphyritic texture varies from widely spaced prismatic phenocrysts set in a fine-crystalline groundmass, to a somewhat closely netted aggregate. Occasionally, the phenocrysts of the coarser porphyry have their longer dimensions oriented in one direction which indicates a flowage following their crystallization. Usually, however, a medium texture is found. The feldspar phenocrysts vary from a few millimeters to over an inch in length and show good prismatic or equidimensional euhedral form. Zoning and polysynthetic twinning with feldspars can be seen with the naked eye. Some irregularly-shaped feldspar crystals are present which indicate absorption. The groundmass is very dark and dense.

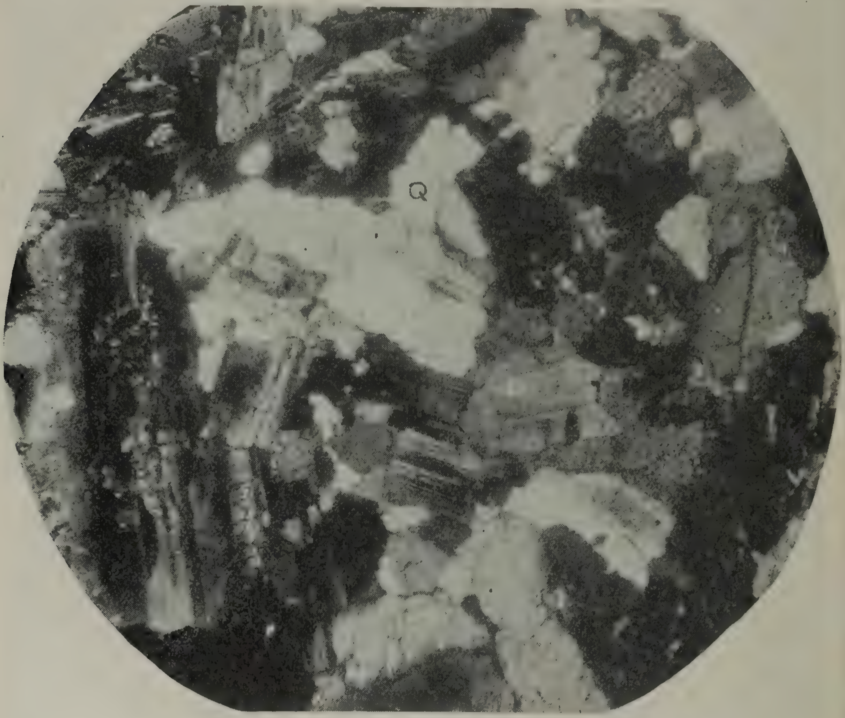

FIG. 20. Thin section of diorite composing a marginal border of the quartz diorite-monzonite body. Q—quartz, B—biotite. 60 diam. x-nicols.

The most common variety of the intrusive is a dense, greenish-black rock composed almost wholly of andesine feldspars, ranging up to several millimeters in length, in dense dark groundmass of hornblende, biotite, feldspar, magnetite, titanite, and apatite. The average granularity of this rock is coarser than the groundmass composing the porphyritic phase.

Along the east wall of the North Fork canyon proper, north of Iron Creek, are several bodies of dark intrusions which are biotite-diorite in composition. These are genetically related to the finer crystalline phase of the major diorite porphyry of which they are probably offshoots.

Scattered through the dense fine-grained rock or matrix of the porphyry, in various localities, are spheroidal, ellipsoidal, and irregular forms composed of milky quartz ranging from a quarter of an inch up to one inch in diameter. Most of these amygdaloidal-like forms are solid throughout but some of the larger ones display cavities lined with fine to medium-sized quartz crystals and give geode-like forms.

Throughout most of the diorite porphyry intrusion, epidote occurs abundantly as an after igneous effect. Numerous veinlets of epidote occur which range from less than a millimeter up to several millimeters or more in width. In some places the whole rock appears to be epidotized. Milky colored quartz is commonly associated with the epidote.

Few minor intrusions are observed in direct relation with this rock as is also the case of the diabase. This indicates that these rock types are, in themselves, extreme differentiates of the batholitic body. The few basic dikes that are genetically related are similar to the parent bodies in composition.

Aplite dikes are occasionally present in the rock but they are probably related to the marginal diorite of the monzonitic mass. These have been folded, in some cases, which would indicate that the intrusive body was subjected to plastic flow after aplite dike injection. This is quite possible in the early intrusions which followed closely on the main period of folding.

Diorite.—Diorite occurs principally as a border phase of the quartz monzonite-diorite body which composes the larger part of the Sierra Nevada batholith. Although a good deal more of this rock occurs than has been mapped, only that portion showing a definite intrusive relation was recognized. For this reason it is probable that much of the rock in the granitic areas of the upper Minaret Creek and the basins of Garnet and Thousand Island lakes is dioritic but is gradational to the main body. The larger part of the border rock shows considerable variation in texture and composition. Texturally, it varies principally in grain size, while the composition varies from quartz diorite to quartz monzonite. The principal occurrence is found in the upper basin of King Creek, on the south slope of Iron Mountain, and Iron Creek basin. As such, the rock forms a somewhat U-shaped margin which extends around the southern extremity of the Ritter Range and occurs largely between the metamorphic and basic intrusive rocks and the outlying monzonitic diorite body.

On the west slope of Iron Mountain the diorite is generally a dark-gray, medium to coarse-grained, crystalline granitic rock which is composed essentially of oligoclase feldspar, hornblende, and biotite with minor amounts of quartz, orthoclase, titaniferous magnetite, apatite, zircon, and titanite. Secondary minerals, as epidote, zoisite, sericite, chlorite, and leucoxene, are common. The latter forms secondary bodies about the magnetite. Hornblende constitutes the most abundant dark mineral and occurs as short greenish black prisms, ranging from 2 mm. to 4 mm. in length and rather evenly distributed through the rock. The rock is essentially a hornblende-biotite diorite.

A sample of diorite taken on the southwest slope of Iron Mountain near the monzonite contact was a dark-gray medium to fine-grained rock, approaching a diabasic texture and composed essentially of quartz, orthoclase, oligoclase, hornblende, and biotite. On Iron Creek this body shows complications within itself. Here, it is essentially a gray and medium grained, intruded by a dark, coarser grained rock, which in turn intrudes a coarse crytalline diabase.

East of the Ritter Range, at the head of King Creek basin, the diorite is of lighter appearance, for the ratio of light to dark minerals is approximately three or four times greater. Here, the rock is largely light-colored, medium-grained, and granitic, composed principally of oligoclase, quartz, biotite, and hornblende, with minor amounts of orthoclase, apatite, magnetite, and zircon. The light minerals are of a dull-gray appearance and form the larger bulk. The hornblende occurs in prisms up to 5 mm. in length, while biotite forms minute aggregates and individual plates up to 2 mm. in diameter. Near the metamorphic contact, in the upper King Creek basin, the rock is rather dark-gray in appearance and medium to fine-grained. Hornblende is generally lacking, while bioite forms the most essential mineral, and the rock may be called a biotite-quartz diorite.

Border facies are commonly fine-grained and of light color, but with an occasional grayish tone, due to the presence of darker minerals.

On the southeast shoulder of Iron Mountain a considerable amount of included material occurs in the bordering diorite. These inclusions range from small to large proportions, and vary considerably as to shape, but generally have a rather uniform field appearance. Though some of these may be primary igneous inclusions, it is probable that the larger bodies are inclusions of country rock which have undergone considerable change as a result of intrusion. These are in marked contrast to the lighter granitic rocks of this vicinity.

The diorite is later than the diorite porphyry and earlier than the quartz monzonite. Although the intrusive relations are distinct in the vicinity of Iron Mountain, a large portion of the rock is gradational with the monzonitic mass, as it forms a marginal phase of that body.

Quartz Monzonite-Diorite.—Composing the main body of the Sierra Nevada batholith, the quartz monzonite-diorite body is the largest unit of igneous rock which was mapped. This includes rocks ranging from light-colored granite to gray diorite, varying in texture from fine-grained equigranular to coarse porphyritic types. The larger part of the rock is generally a rather light ,medium-grained hypidiomorphic granitic rock of intermediate composition. The body with its various facies intrudes, embays, and outlies the metamorphic rocks of the Minaret region. In the southern and western portion of the area mapped these rocks constitute the most widespread type. Here, the larger part consists of three distinct facies which are essentially quartz monzonite, quartz diorite, and granite.

In the vicinity of '77 Corral, south of Iron Mountain, the rock s of quartz monzonitic nature. Here it is a very light-colored medium-grained granitic type, composed of cloudy quartz, pale, flesh-colored orthoclase and oligoclase feldspar with green hornblende and biotite. Titanite, apatite, zircon, and magnetite are also present. The hornblende occurs in prisms up to 5 mm. in length, while the biotite forms plates up to 3 mm. in diameter. Both of these occur in nearly equal proportions and compose about one-third the volume of the rock.

In the general vicinity of Soda Springs and Red Meadow, the granitic rock takes on a distinctly coarse porphyritic texture with large crystals of orthoclase scattered through a coarse crystalline matrix composed of cloudy quartz, white feldspars, and biotite. The ortholase is generally of white color of which individual crystals range up o two inches in length. Biotite forms the most abundant of the dark minerals and occurs evenly distributed through the groundmass as rregular flakes and tablets up to 3 mm. in diameter. Hornblende is sparsely present. On a weathered surface these phenocrysts stand out prominently and commonly show good carlsbad twinning.

In the vicinity of the Granite Stairway, south of Snow Canyon, he granitic rock has quartz dioritic affinities, with abundant autolithic nclusions. A specimen from this vicinity showed a medium to coarse-grained crystalline granitic rock composed of white oligoclase feldspar, cloudy quartz, hornblende, and biotite. Well developed prisms of hornblende range up to 1 cm. in length. Biotite occurs as hexagonal plates up to 3 mm. in diameter. Titanite can be seen with the naked eye as prominent brown wedge-shaped crystals scattered through the rock. Other accessory minerals include magnetite, apatite, and zircon.

Specimens of granitic rock from the upper North and South Forks of Minaret Creek show it to be a rather dark grey to light, medium-grained hornblende-biotite quartz diorite.

In the upper basin of the North Fork of San Joaquin River at the western contact of the metamorphic group, the rock is a light, medium-grained biotite-hornblende quartz diorite. Microscopically, it contains uartz, oligoclase, orthoclase, together with green biotite and hornblende. Magnetite, titanite, and apatite constitute the accessory minerals. A little to the south, in the upper Bench Creek Basin, the rock is generally a granite in composition but somewhat variable in texture. Near the contact, it is essentially porphyritic with whitish crystals of orthoclase feldspar, ranging up to a quarter of an inch in length in a fine to medium-grained groundmass. Some distance from the contact, the rock is equigranular, medium to coarse-grained, and contains a relatively greater abundance of femic minerals. A specimen of this was a light-colored medium-crystalline rock, composed of quartz, orthoclase, oligoclase, microcline, hornblende, and biotite. The hornblende and biotite occur respectively as short prisms and small hexagonal tablets which range from 1 to 2 mm. in length and diameter. Titanite, magnetite, zircon, and apatite were present as minor accessory minerals.

Much of the border of the quartz monzonite body is undoubtedly diorite in composition and genetically related to the recognized portions but the contact relations are gradational and indefinite. Border phases of this kind are to be found especially in the upper King Creek basin.

In the vicinity of Fernandez Pass the granitic rock is essentially a biotite-hornblende quartz monzonite. It is a light even-grained, medium-coarse rock composed largely of cloudy quartz, orthoclase, oligoclase, biotite, and hornblende. The two latter occur in nearly equal abundance and compose about one-fifth of the rock bulk. The hornblende forms well-developed prisms which range up to 5 or 6 mm. in length, while the biotite forms hexagonal or irregular plates up to 3 or 4 mm. in diameter. Magnetite, apatite, and titanite are accessory minerals.

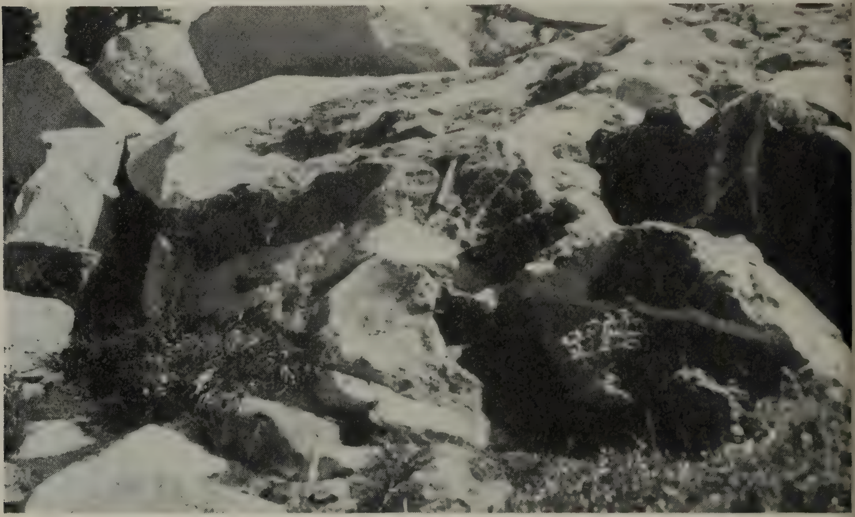

FIG. 21. Plutonic contact with quartz monzonite (light) intrusive into a diorite border phase (dark).

East of Fernandez Pass and immediately south of Sadlier Lake the granitic rock is essentially a biotite granite, while in the vicinity of Clover Meadow, it is a light medium to coarse-grained biotite-hornblende quartz diorite.

In the northeastern portion of the Minaret region the granitic rock is largely equivalent to the diorite border phase of the quartz monzonitic body but it is somewhat variable in texture and composition. Considerable variation exists within the Thousand Island Lake Basin and especially at Island Pass. Here three distinct facies are found. First, there is a hybrid border phase of very fine-grained, light to gray porphyritic quartz diorite which, microscopically, consists of phenocrysts of biotite and oligoclase in a micro-crystalline granular groundmass of quartz, plagioclase, orthoclase, biotite, and hornblende. Titanite, magnetite, and apatite make up the accessory minerals. The feldspar phenocrysts have been broken and resorbed by material composing the groundmass. The magma intruded a series of meta-volcanics and interbedded sediments, incorporated and assimilated them to a certain degree. A primary gneissose texture is preserved in places. The hybrid or border phase grades into a more general and widespread granitic rock. This is essentially a gray, medium-grained quartz diorite which contains oligoclase feldspar and green biotite with a small amount of hornblende. Apatite, zircon, titanite, and magnetite form the accessory minerals. The biotite forms large hexagonal tablets which range up to 5 mm. in diameter. These are scattered through a finer matrix composed of feldspar and biotite and give the rock a spotted appearance. This phase grades into a very dark, coarsly-crystalline hornblendic rock of dioritic affinities. The hornblende is very abundant, coarsly crystalline and commonly forms prisms which range up to several inches in length.

On the Garnet-Thousand Island Lake Divide, the granitic rock shows two border phases which are related to similar types found to the north. One is a fine, dark-gray, even-grained diorite which grades into a porphyritic contact border phase. In the latter, cloudy quartz phenocrysts occur in a bluish-gray groundmass composed of quartz, feldspar, and muscovite.

A stock of granitic rock in the upper basin of the Middle Fork of San Joaquin River is composed essentially of granite and quartz monzonite. The rock is generally a medium-grained light-colored granitic type, composed of quartz, orthoclase and oligoclase and a small amount of evenly disseminated flakes of biotite averaging about 1 mm. in diameter. Occasional large crystals of orthoclase give the rock, in part, a rude porphyritic texture. This body is genetically related to the granitic intrusives of the basins of Garnet and Thousand Island lakes.

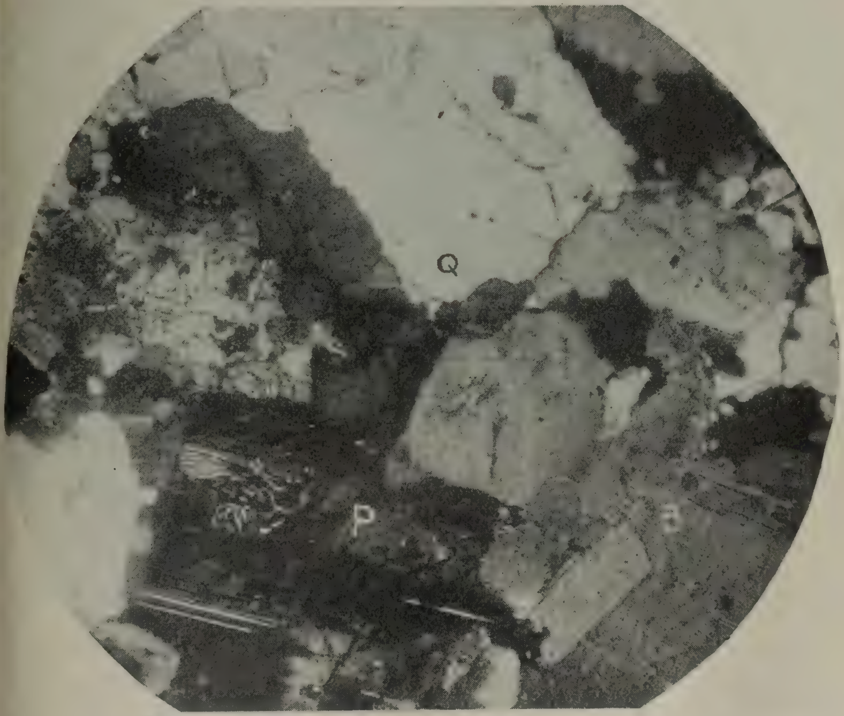

FIG. 22. Thin section of quartz diorite from Granite Stairway. Q—quartz, P—oligoclase, B—biotite, V-vermiculite. 60 diam. x-nicols.

There are two main types, dike-injections, associated with the quartz-monzonite-diorite: the acid or aplite and pegmatite dikes, and the basic or lamprophyric dikes. The best occurrence of the various dike systems is to be found in the upper basin of the Middle Fork of Minaret Creek. Here, one system of early aplite dikes cut a system of basic dikes which, in turn, are cut by a second system of aplite dikes.

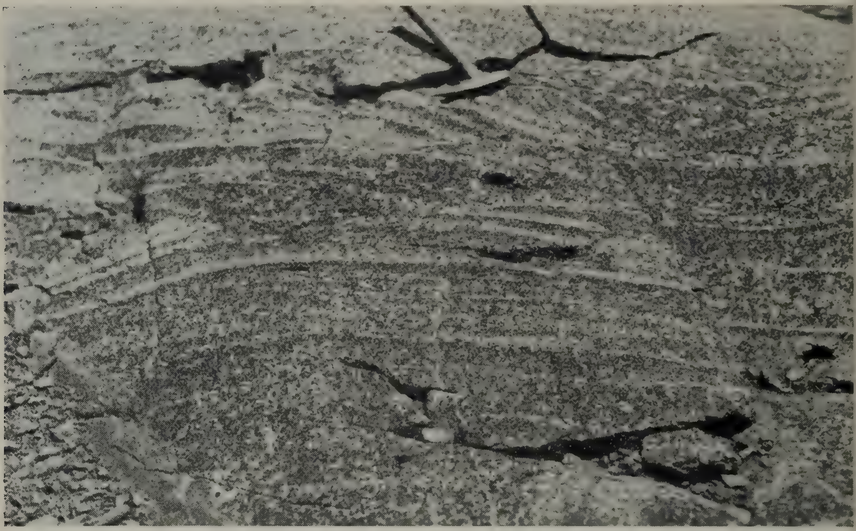

FIG. 23. Flow-structures developed in a hornblende rich diorite near summit of Island Pass.

Micro-pegmatitic Granite.—The granitic rock of the upper Iron and Dike Creeks is, petrographically, the most interesting intrusive rock to be found in the whole region. It composes a large stock which stands in marked contrast to adjacent darker rock types in that vicinity. Besides the main body, there are several other occurrences of lesser extent found on the southwest slope of Iron Mountain, in the upper Shadow Creek Basin and in the saddle on the Volcanic Ridge.

In the hand specimen it is pale pink to flesh-colored, with quartz and orthoclase apparently making up most of the rock, while the dark minerals are present in minor amount. A porphyritic texture is suggested, with pinkish to cream-colored orthoclase crystals 5 mm. in length, set in a medium to finely crystalline matrix of quartz, feldspar, and little hornblende. The hornblende occurs as small aggregates or individual crystals. Near the contact the rock is generally finer and more evenly crystalline and the mineral composition generally more basic for it probably ranges from an alkali granite to the monzonitic type near the border.

Microscopically, the rock shows an excellent development of graphic texture composed predominately of an intergrowth of quartz and orthoclase. Oligoclase feldspar is present in less abundance with vermicular quartz borders giving myrmekite and in part intergrown with orthoclase to give perthite. A small amount of microcline is shown by a fine grating. Both hornblende and biotite are a bright green variety and sparingly present in the rock. A slight amount of ti-magnetite, titanite, and zircon crystals occur as accessory minerals.

On the southwest slope of Iron Mountain an elongated body of rock occurs which at first sight appears to be a different type but on close examination was found to be a border phase of the main micro-pegmatitic granite to the north. Here, it is a light pale cream-colored medium-grained rock composed essentially of quartz and orthoclase in graphic intergrowth with subordinate oligoclase and microcline. Green hornblende forms the most important characterizing mineral and biotite is notably lacking. Titanite and ti-magnetite are present as important accessory minerals.

An important late phase of igneous activity in the micro-pegmatitic granite has been the development of vermiculite as the result of auto-metamorphism. A rock similar in many respects to this rock has recently been described as being entirely of late and post-magmatic replacement origin.[9]

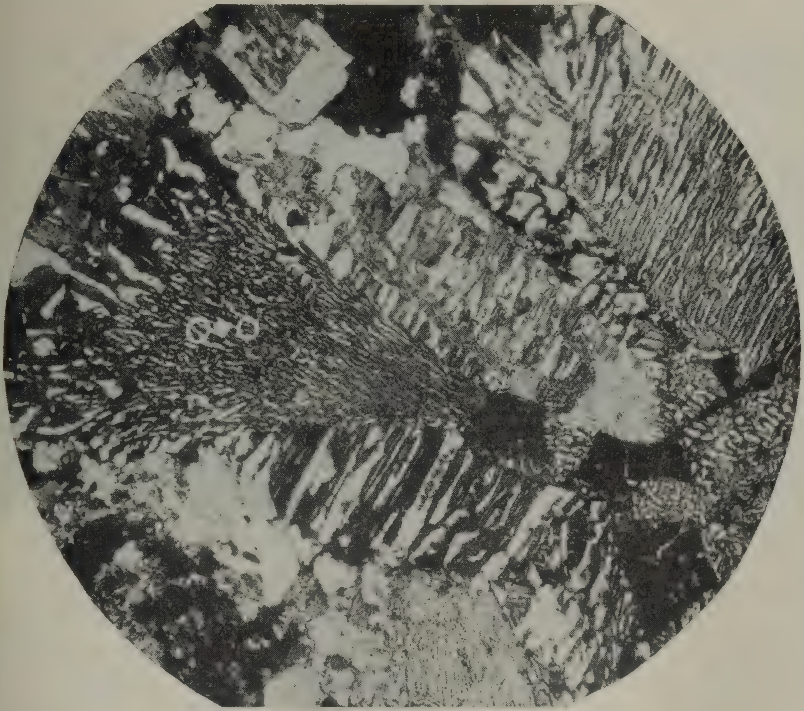

FIG. 24. Thin section of a micro-pegmatitic granite from Iron Creek. Composed essentially of quartz (Q) and orthoclase (O) in graphic intergrowth. 50 diam. x-nicols.

Occasional small aplite dikes were observed and these were generally of small dimension. Quartz veins of hydrothermal origin cut the rock.

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[9] Gilluly, James, Replacement origin of the albite granite near Sparta, Oregon: U. S. Geol. Survey Prof. Paper 175C, 16 pp., 1933.

Throughout the area the micro-pegmatitic granite was observed to be intrusive only into the diorite and diorite porphyry and the metamorphic rocks. Thus, it is post-dioritic and, on a basis of texture and composition, it is undoubtedly later than the main quartz monzonitic-diorite body. The contact with adjacent rocks is rather even and regular. There is some evidence of strain and shearing produced on the intruded rocks, especially the diorite.

Igneous Metamorphic Complex of King Creek.—In the upper basins of the North and Middle Forks of King Creek, west and north of the Beck Cabin, the geology is exceedingly complex. Over a broad area the rock is neither wholly metamorphic nor igneous but is an intimate complex of both. Usually, this complex is composed of alternate metamorphic and granitic rock into which a complicated system of basic dikes have intruded. In the complex, a diorite porphyry intruded, first into the metamorphic rocks which consist essentially of light-gray meta-dacitic crystal tuff and biotite schist. The injections were controlled by the strike of the metamorphics which is N. 65° to 80° W. Following the poryhyry intrusion, a granite rock welled up along the dikes and strike of the metamorphic members. This rock is a hornblende-biotite diorite in composition which is the border phase of the monzonite body. Following the diorite, abundant basic dikes were intruded which range up to 20 or 30 feet in width. There appear to have been several impulses during the injection as multiple dikes can be noted. The whole complex is cut out to the east by the later quartz diorite-monzonite rock body.

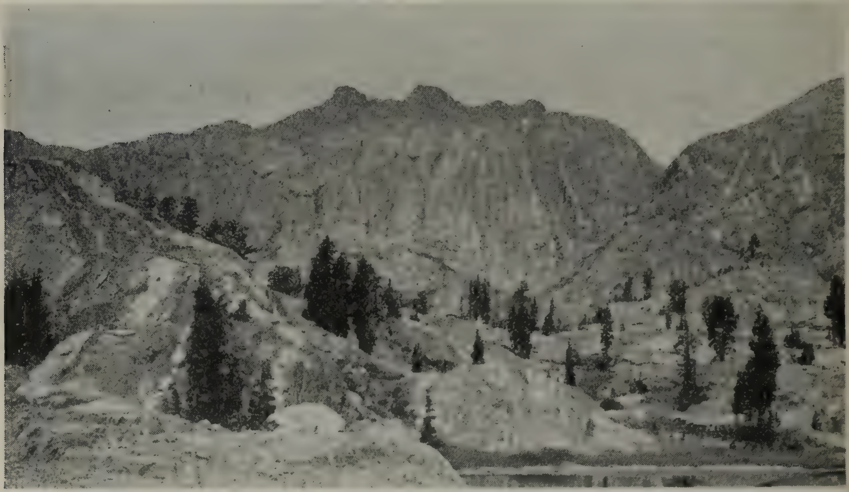

FIG. 25. Igneous-metamorphic complex in the Upper Basin of King Creek.

SEQUENCE AND AGE OF THE INTRUSIONS

It has been demonstrated that definite units or differentiates of intrusive rocks occur which have intruded in a definite order, shown by the field evidence to be one of increasing silicity. The first to have intruded is a basic type known as diorite porphyry. Contemporaneous with this is a texturally different rock designated as an andesine diabase. Following these the main batholithic rocks were intruded. An exterior diorite border phase solidified first, followed by the interior masses of quartz diorite and quartz monzonite. The last body to intrude was a rather alkaline rock of micro-pegmatitic granite. The time relations between all of these is not believed to be great. As shown by the field contacts, each type had generally solidified before intrusion of the next but in many cases a gradational or vague relation exists. This is especially true within the main mass of granitic types.

The subordinate intrusions, which include dikes, are distinctly of a later time than the enclosing granitic types for they not only cut these rocks but are more finely crystalline. This is especially true of the more basic dikes, which show evidence of forcible injection. Considerable time probably elapsed before these were intruded. The mineralizing solutions were later than any of these.

The age of the intrusions, which represents one general period of activity, can not be definitely established in the rocks of the Minaret region, excepting that they are post-metamorphic. The intrusions are, however, a part of the general granitic types found elsewhere in the Sierra Nevada which compose the batholith and the age of this has been established as late Jurassic or lower Cretaceous.

Extrusive Rocks

The volcanic lavas and associated pyroclastic materials which overlie the eroded surface of the granitic and metamorphic rocks constitute the third important class of rocks to be found in the Minaret region. The lavas are the most abundant of the volcanic materials and show considerable variation in age and composition. In general, however, they are placed in two age groups. The first group is the oldest and includes basalt at the bottom and andesite at the top. The second group is distinctly later and is represented by only one member which is basaltic in composition.

The older group of lavas are believed to be of Miocene age, while the later lava is probably Pleistocene. Following the last flow of lava, explosive eruptions from craters east of the Sierra Crest spread a mantle of pumice over the eastern portion of the region. This activity closed a long but intermittent period of vulcanism which began in late Tertiary and continued to nearly Recent time.

Tertiary Volcanic Rocks (Basalt).—Tertiary basalt is the most abundant volcanic rock whose most prominent occurrence is along the east wall of the Middle Fork Canyon between Minaret Summit and Agnew Pass. Here, the lava consists of a group of nearly horizontal flows which front the river and range considerably in thickness from north to south. Stream and glacial erosion have cut into and removed the once more extensive flows and thus exposed the internal structure of the series as can be readily seen on the crest east of Agnew Meadows. The individual flows are generally rather thick and stand out to give a somewhat bold step-like slope to the canyon wall and bench appearance to the divide. North of Agnew Meadows the group of flows extends nearly to the river and probably attains a maximum thickness which is estimated to be slightly in excess of 1500 feet west of San Joaquin Mountain. At Deadman Pass the group has a minimum thickness of about 200 feet. The exact number of flows in this group is not known for they vary considerably from place to place, but it is quite likely that the thicker portions do not exceed 36 individual flows. The flows appear to be made up of four distinct groups, as shown by the profile of the east canyon wall between Agnew Pass and San Joaquin Mountain. Interbedded with the lava are minor amounts of basaltic lapilli and cinder. Many of the flows exhibit a wide columnar or blocky jointing. With respect to the lower contact of these flows, it is interesting to note that most of the streams which drain the east slope of Middle Fork Canyon emerge from under these flows. The extremely fractured nature of the lava allows a downward seepage of water which flows out upon reaching the tight unconformable surface of the underlying metamorphic rocks.

In the field this basalt generally exhibits a light to olive-brown appearance, caused by weathering, but a fresh surface shows the rock to be very dense and of greenish-black appearance. Olivine is abundant and appears to be, to the naked eye, the only recognizable mineral. This mineral weathers readily and gives a pitted surface to the rock. Under the microscope, the rock is found to exhibit a very fine texture, containing abundant labradorite microlites, and olivine with some colorless augite and accessary magnetite. Very little glass is present. As such, the rock is an olivine-augite basalt.

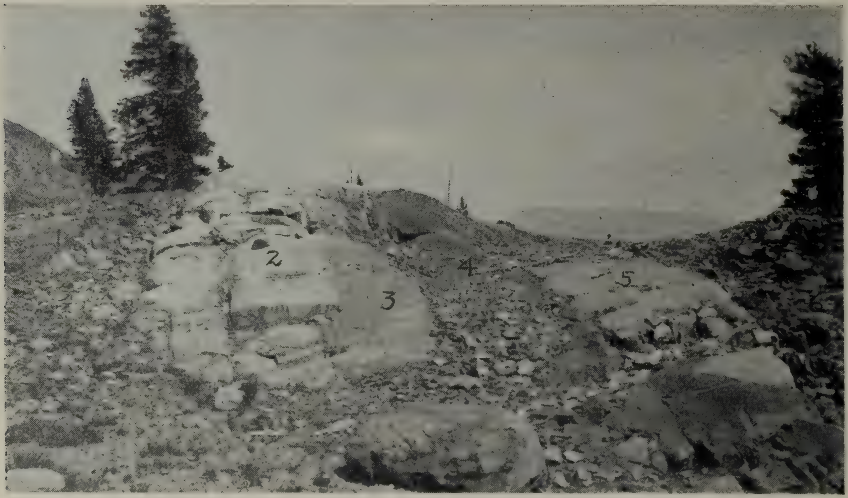

FIG. 26. Details of the King Creek Complex. (1) Basic dike. (2) Meta-dacitic tuff. (3) Diorite. (4) Basic dike. (5) Diorite. (6) Biotite schist.

Remnant caps of former extensive flows are to be found throughout the general region. Some of the larger caps are found south of Iron Mountain between the North and Middle forks of San Joaquin River, in the Upper East Fork of the Granite Creek basin and in the vicinity of Clover Meadow. The smaller caps usually consist of only one distinct flow, while large ones may consist of two or three flows which range up to 200 feet or more in thickness. The rock looks like the basalt of the Middle Fork Basin and has essentially the same composition. A pronounced flow-sheeting is developed in some of the lava.

This basalt, as already stated, is the oldest and most widespread of the volcanic rocks. The origin remains a question for the most part, as the original craters have long since been destroyed by erosion. The indication is that the lavas originated from craters which stood east of the present Sierra Crest and flowed in a southwesterly and southerly direction from the different centers of origin. One cap near the head of the Granite Stairway shows a well consolidated, coarse, pyroclastic rock which contains large bounders of granite and may indicate a near source for the lava.

(Andesite).—Next in abundance to the basaltic lavas of the older group are the andesitic types that overlie them. Generally, the andesitic portion shows slightly unconformable relations with the basic flows of the lower group. The andesites are divided into two types according to field appearance. First, there is the lower dark-pink rock which makes up the bulk of Mammoth Mountain and a portion of the Sierra Crest between Deadman Pass and a point north of San Joaquin Mountain, and second, the lighter-colored flow-rock which composes the Two Teats and vicinity and is the highest lava in the older group. The maximum thickness of the andesite in the vicinity of San Joaquin Mountain is about 1000 feet, while near Deadman Pass the group narrows down to less than 100 feet.

The andesite composing the greater bulk of Mammoth Mountain is largely a pinkish-brown porphyritic rock in which andesine feldspar phenocrysts make up about one-quarter of the rock volume. They vary from anhedral to subhedral crystals which range up to 4 mm. in length. Biotite is scattered through the rock as bronze-colored hexagonal tablets ranging up to 3 mm. in diameter. Feldspar, microlites, volcanic glass, magnetite, and apatite form the groundmass. A pronounced flow structure is usually present and there is little vesicularity. Near the bottom of the Mammoth Mountain andesite, on the north side, the rock is black and composed almost wholly of glass. On the summit of Mammoth Mountain the rock is streaked, bleached and colored, caused by hydrothermal and solfataric alteration.

North of Mammoth Mountain, along the Sierra Crest, the andesite takes on several different field appearances. The lowermost flows have a chocolate to reddish-brown outward appearance but a fresh fracture shows a dense light to dark-gray rock. The brighter surfaces are due to the original cooling. In thin sections, the rock is distinctly porphyritic with phenocrysts of andesine in a micro-crystalline to glassy groundmass which contains abundant plagioclase microlites. Brown biotite and basaltic hornblende are generally present as prominent crystals and show strong absorption colors in shades of deep reddish brown. These minerals appear to have been attacked by gases with a resulting dark opaque border which is possibly magnetite. The accessory minerals are magnetite and apatite. In some specimens basaltic hornblende is lacking but biotite is consistently present.

The lower andesite includes much fragmental material in the vicinity of San Joaquin Mountain. These inclusions are angular to circular or ellipsoidal in shape and range up to six inches or more in diameter, although generally they are smaller. The rock is very fine-grained and appears to be a pre-existent tuff which was incorporated by the andesitic lava.

The lighter appearing andesite composes the bulk of the Sierra Crest in the immediate vicinity of Two Teats. This rock presents an ash-gray appearance with pale, cream-colored plagioclase phenocrysts, a few minute dark reddish-brown crystals of biotite and hornblende in an aphanitic groundmass with abundant elongated pores or cavities. Microscopically, the feldspar is andesine, well trimmed and ranges up to 4 mm. in length. Brown biotite and basaltic hornblende are sparingly present but have been corroded, giving a dark opaque border. Some tridymite may possibly be present. Apatite and zircon constitute the accessory minerals. The groundmass consists of plagioclase microlites and glass.

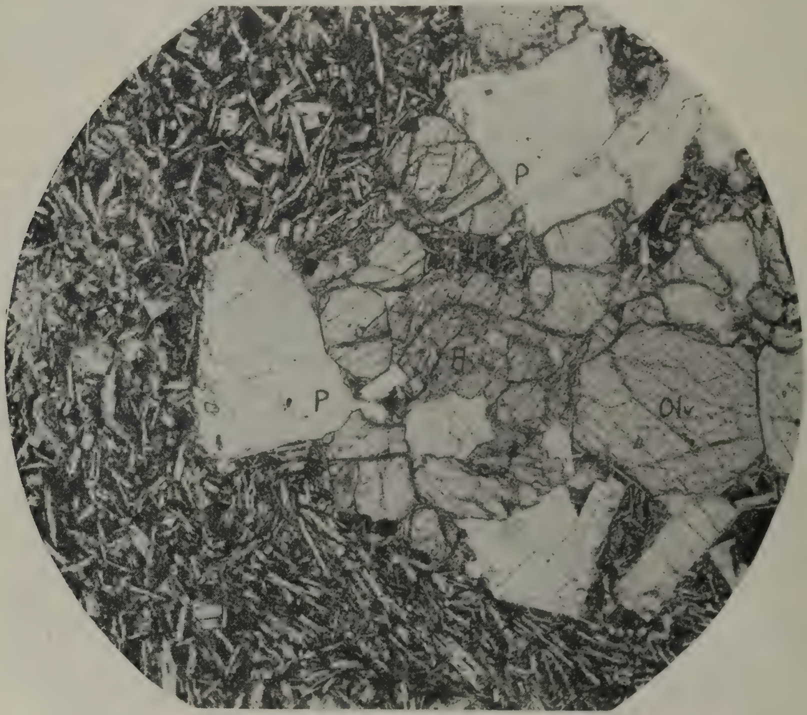

FIG. 27. Thin section of Devil's Postpile basalt which is composed of phenocrysts of labradorite (P) feldspar, olivine (Olv.), and augite (A) in a micro-crystalline groundmass of feldspar microlites, glass, and magnetite. 50 diam. Ordinary light.

Quaternary Volcanic Rocks (Basalt).—Basalt occurs principally on the floor of Middle Fork Canyon and contiguous portions of the canyon slope between Pumice Flat and Fish Creek Valley. Two important occurrences are recognized. One mass extends from the head of Pumice Flat down to a point about two miles below Rainbow

Falls and up the canyon slope to Mammoth Pass with several outlying masses. The other large occurrence is in the vicinity of Pumice Butte.

The most spectacular portion of the rock is that which constitutes Devil's Postpile. Here, the rock generally has a chocolate color on an original cooled surface but inwardly it is essentially black and distinctly porphyritic. The phenocrysts are subhedral plagioclase feldspars, ranging up to 8 mm. in length and 3 mm. in width.

Under the microscope the rock is found to be composed of labradorite feldspar, olivine, and colorless augite as larger crystals in a microcrystalline groundmass composed of microlites of labradorite, augite, magnetite, apatite, and brownish glass. The groundmass shows a hyalopilitic texture. The phenocrysts make up about 25% of the rock bulk with the groundmass forming the balance.

The lava is generally vesicular and often exhibits a crusted and rough surface. Columnar structure is common and is best shown by the Devil's Postpile.

The lava appears to have had its origin in a fissure in the vicinity of Mammoth Pass, and from the orifices of the Red Cones and Pumice Butte. It poured forth into the previously glaciated Middle Fork Canyon and accumulated to a maximum depth of 700 to 800 feet in the vicinity of the Devil's Postpile. With the second advance of the Middle Fork glacier, the larger part of the lava was removed leaving only the remnants that exist today. The cones on the bench east of the river canyon were above the ice and hence were not materially altered by it.

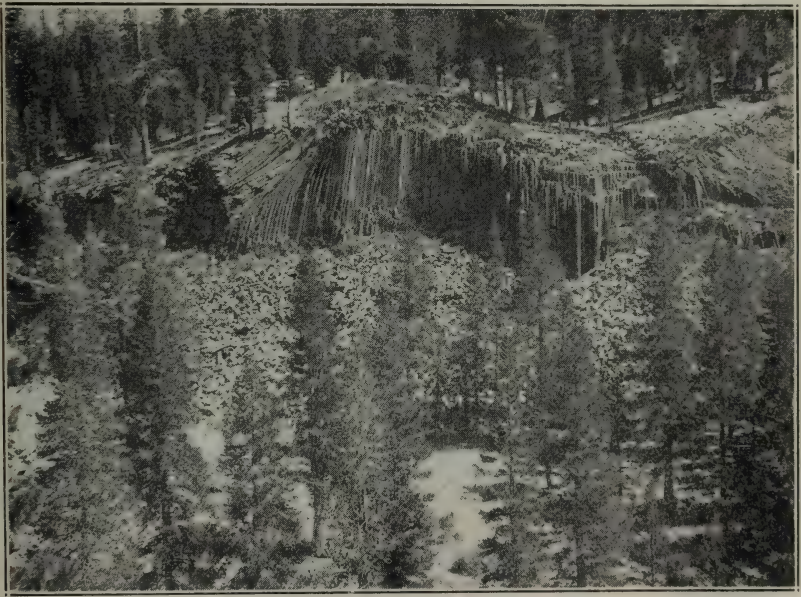

FIG. 28. Devil's Postpile. Famous example of highly developed columnar jointing in basalt. A National Monument located on Middle Fork of the San Joaquin River.

Photo by Walter W. Bradley.

In the vicinity of Sotcher Lake and Reds Meadow there is an occurrence of tuff which is believed to represent the waning of this period of igneous activity. It is a pink to white-colored, fairly well consolidated crystal-lithic tuff which underlies a thick mantle of pumice and forms the immediate break in slope, east of the stream draining from Sotcher Lake. The bed of the hot spring at Red Meadow is in this rock.

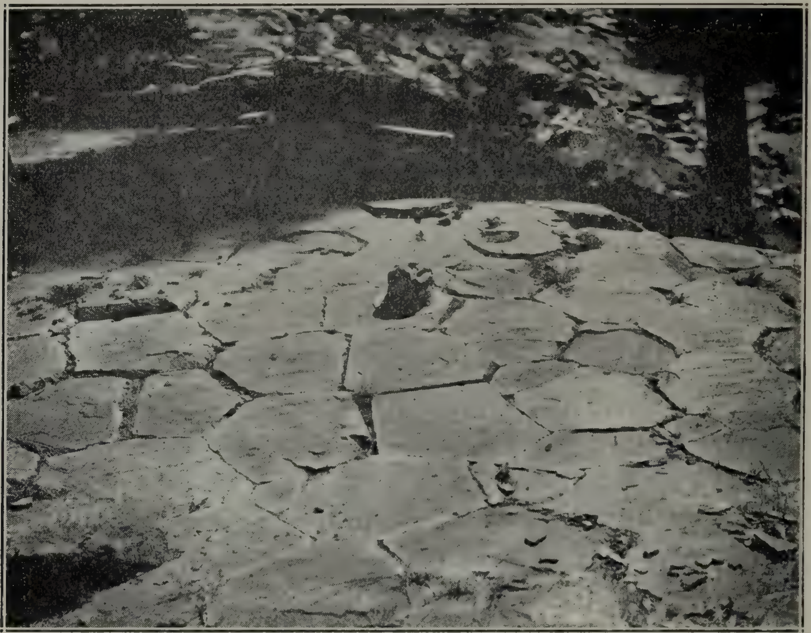

FIG. 29. Glaciated surface on top of basaltic columns at Devil's Postpile. Shows pentagonal pattern of columns. Note striae showing direction of ice flow from left to right.

Photo by Walter W. Bradley.

RECENT VOLCANIC PHENOMENA

The evidence of present-day volcanic activity in the region is exemplified by the presence of cold and hot mineral springs and steam vents. Both the hot and the cold mineral springs are due to the rise and surface seepage of juvenile waters originating in submarine volcanic chambers. In the case of the cold springs, however, the waters have been sufficiently cooled before reaching the surface. Examples of the hot springs are found at the head of Pumice Flat, Soda Springs Meadow, and elsewhere. The Reds Meadow and Fish Valley Hot Springs are the only examples of hot springs.

There is much evidence of comparatively recent effects of volcanic waters in the region. Such activity is shown by the solfataric alteration of the rocks in certain localities. The streaked and bleached summit of Mammoth Mountain is one example. In the vicinity of the Red Cones, the granitic rock has been badly decomposed by volcanic water and vapors.

Pumice.—After the total evacuation of Pleistocene glaciers, in comparatively recent time, a series of volcanic explosions began in the adjacent territory north and east of the Minaret region and spread a shower of pumice over a large part of the eastern Sierra Nevada in this vicinity. The material is a whitish-gray porous substance occurring in small pellets up to an inch in diameter. As a result of weathering, these have been ground into a fine dust which is commonly mixed with the soil and other materials. This shower of siliceous material accumulated to great depth in places and has been little consolidated or removed by erosion. Such locations, west of the Sierra Crest, generally exist on the east slope of the Middle Fork Canyon from the summit of Sierra Crest down to the Middle Fork River and between Agnew Meadows and Pumice Butte. The streams are small on the slope of this canyon and have effected little removal of the material.

Sedimentary Deposits

The sedimentary deposits in the Minaret region include those of glacial and post-glacial origin. The former consists chiefly of morainal material, while the latter includes the stream and lake deposits, the soil, and talus. It is difficult in many cases to separate the sediments according to their respective origins for much of the post-glacial material is undoubtedly reworked glacial till.

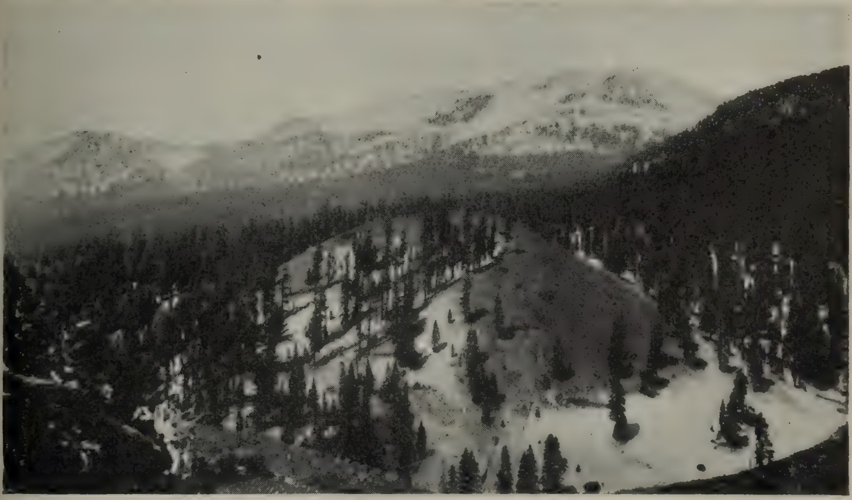

FIG. 30. Cinder cones situated at brink of east wall of Middle Canyon about six miles southwest of Mammoth Pass. Note breeched character of crater in foreground.

The glacial deposits include moraines, sheets, irregular masses of material, and erratic boulders which have been deposited by the action of the ice. The first three are found in relatively flat areas, while erratic boulders are of wider distribution. High-crested moraines are usually absent except for some recessional moraines of comparatively recent date, situated high up the valleys, as above Thousand Island and

Garnet Lakes. A few large and fairly well preserved lateral moraines of earlier age occur on the south slope of Iron Mountain in the vicinity of '77 Corral and in the upper Iron Creek basin.

The post-glacial deposits include the products derived from stream erosion, disintegration, and exfoliation. Among the more important are the stream and lake deposits, as well as the soil and talus accumulations. Pumice is mixed with all of the sediments. Following the retreat of the glaciers, the streams became active in removing material from the steeper portions of their courses to be deposited in the flatter portions. As a result, broad flats were built up at intervals along the stream courses which are composed of stream-washed sands, gravels, and coarse materials. These flats are commonly of considerable extent and often support abundant plant life in large sub-alpine meadows, as on the Middle Fork River, Shadow Creek, above the lower Minaret Falls, Soda Springs Meadow, and elsewhere.

Besides the abrasive action due to stream and rain wash, disintegration has been an important agent in rock decay. This is especially true in the granitic rocks of the region. The combined weathering effects controlled by joints have produced material ranging from coarse gravel up to huge blocks weighing many tons. The general weathering process has been largely mechanical and accomplished by abrasion and differential temperature effects.

STRUCTURAL GEOLOGY

Folding

The area of metamorphic rocks presents a truncated surface of highly folded rocks whose strike is in a northwesterly direction and approximately parallel to the general trend of the Sierra Crest. The parallel arrangement of the metamorphic members striking across the country is quite evident in the Middle Fork basin when viewed from points along the Sierra Crest. The schistosity of the more altered rocks is generally regarded to be largely coincident with the bedding and flow structures of the original rocks. In at least two localities, however, some deviations were observed. A biotite schist member, at the lower end of Thousand Island Lake, revealed a 12° deviation, while a limestone member near the summit of the Shadow-Minaret Creek divide showed a deviation of 15°. The strike of the metamorphic rocks varies from N. 15° W. to N. 60° W. and the dip from 70° to the northeast to vertical and also to as low as 30° to the southwest. On an average, the strike is about N. 35° W. and dip around 75° to the southwest. Along the east wall of Middle Fork Canyon the strike varies from N. 65° W. and vertical dip to N. 20° W., and dip of 65°. A marked change in attitude is to be found high on the canyon slope east and north of Agnew Meadows, where the rock dips toward the northeast at about 70°, probably due to faulting. On the west side of Middle Fork Canyon the metamorphic rocks have a strike of N. 30° to 40° W. and dip from the vertical to 70° to the southwest. Slight changes in attitude are probably due to emplacement by igneous intrusions in some cases.

In the North Fork basin the strike of the rock from south to north varies from N. 15° W. and dip of 65° southeast, to a strike of N. 35° W. and dip of 50° southeast.

It is difficult to determine how many folds involve the metamorphic rocks, because it is hard to recognize definite members of the groups which might serve as key-units for identification.

The northwesterly strike and high southwesterly dip is recognized by relic-bedding, flow-structures, and by later superimposed cataclastic and schistose structures. The rocks that generally flank either side of Ritter Range are clearly defined in attitude, whereas those which compose Ritter Range are apparently structureless. This would indicate that the rocks of Ritter Range have suffered less dynamic metamorphism than adjacent rocks. Near the eastern margin of the metamorphic rocks, as shown on the geologic map, the more westerly high-dipping meta-volcanic rocks are found to stratigraphically overlie the slate. If this relation were to hold throughout the total metamorphic assemblage, a total thickness in excess of 55,000 feet would be exposed. It seems very unlikely, however, that such a great thickness of rock could have been deposited and folded in such a comparatively short space of geologic time. It therefore seems more probable that duplication may exist by folding. An isoclinal syncline appears to be present in the Middle Fork basin, while the structure of the rocks of Ritter Range are indefinite and those in the North Fork basin dip prevailingly to the southwest. Evidence of a few minor folds were observed in the vicinity of Garnet Lake. The regional structure may possibly be synclinal to the east and anticlinal towards the west with intermediate related minor folds. If this is true the thickness of the series may be only about 15,000 feet. In the Mineral King district[10] and in the Inyo Mountains[11] over 6000 feet of Triassic rocks are found. It would seem quite possible, therefore, for 15,000 feet of material to have accumulated in the Minaret region during the Triassic and possibly in part during the Jurassic.

If the age of the metamorphic rocks is regarded as upper Triassic to lower Jurassic, the folding of these rocks probably took place prior to the late Jurassic. This was probably the result of compressive forces set up in the earth crust which acted in a general southwest to northeast direction.

Faulting

The faulting includes moderately, low-angle thrusts, reverse and normal faults. These conform closely to the strike of the schistosity in the metamorphic rocks and for this reason are classified generally as strike faults. A few cross-faults are to be found but they are of minor significance. In most cases the faults are difficult to recognize and only the most prominent or important ones were mapped. Although the region is considerably faulted, displacements are generally small.

The period of folding largely antedated the faulting, but, towards the end of the period of compression, the rocks began to be ruptured and to be displaced along the limbs of tight folds, thus giving thrust or high-angle reverse faults. After the granite invasion, regional compression ceased and a readjustment in forces took place. As a result, the region was put under tension and eventually uplifting and unload-

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[10] Knopf, A., and Thelen, P., *Op. cit.*

[11] Knopf, A., and Kirk, E., A geologic reconnaissance of the Inyo Range and the eastern slope of the Sierra Nevada, California: U. S. Geol. Survey Prof. Paper 110, pp. 47–48, 1918.

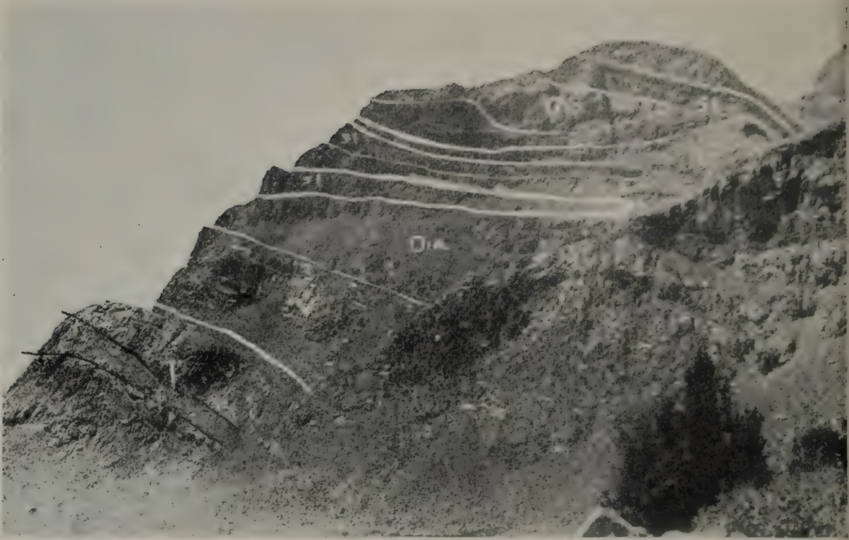

FIG. 31. Thrust planes and geologic relations along a portion of the west wall of the upper North Fork canyon. T—thrust planes, V—meta-volcanic tuffs and flows, Dia—highly altered diabase, Sl—slate.

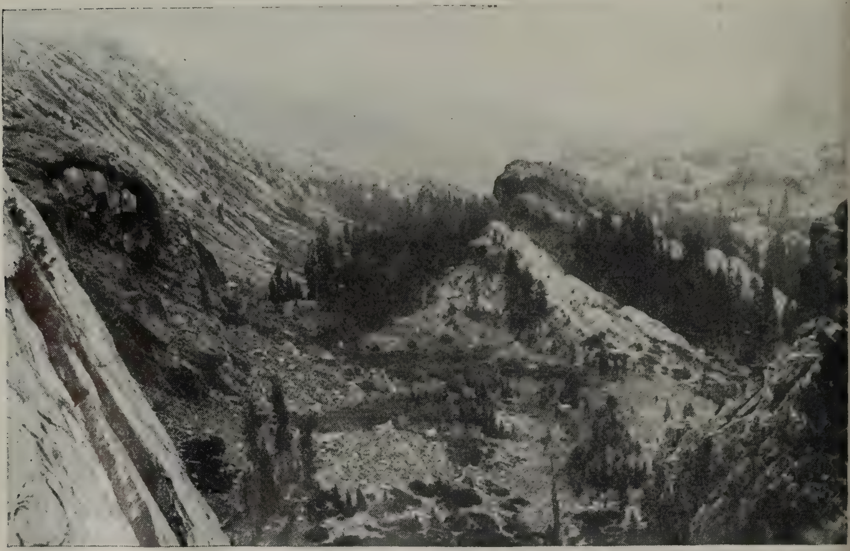

FIG. 32. View looking south in North Fork canyon from a point north of Stephens Meadow. The topographic depression in the center denotes a rift zone.

ing began on a grand scale. Thus, normal faulting was started which eventually resulted in the present mountain block.

Normal faults are perhaps the most important and abundant type in the entire region. These generally occur as strike faults in the metamorphic rocks, conforming with the schistosity and representing a slipping along the planes. The movements are largely younger than the granitic rocks and some are of rather recent time. A good many faults of this nature occur on the east side of the Middle Fork basin in the vicinity of Agnew Meadows and north to Agnew Pass where they form a parallel system. To the west, they are found striking across overhanging valleys and ridges until lost in the granitic areas to the south. One fault follows up Middle Fork river closely to the headwater, where it apparently branches into several faults. These fault lines can best be observed on ridge-crests where they either occupy a saddle or determine a break in the slope by one wall. The vertical displacements along most of these faults do not exceed 500 feet and in many cases are believed to be much less. The tension was relieved along a multitude of these parallel strike faults, consequently no one displacement seems to be great.

In the North Fork basin, one important fault was noted. This lies directly east and parallel to the river for about three miles between Dike Creek and Bench Canyon. The shear zone is several hundred feet wide and forms a long basin-like depression between the east canyon wall and a low ridge on the canyon floor, east of the river. The geologic, as well as the physiographic evidence, shows considerable movement has accompanied this fault. The rocks have been intensely broken and slickensided along the fault zone. The total displacement was perhaps two or three thousand feet.

An example of low-angle thrusting in the metamorphic rocks is to be found in the upper basin of North Fork of San Joaquin River. Here several fault planes can be traced for about two miles along the west wall of the upper canyon immediately southeast of Rogers Peak. These are not profound thrusts, as they are not continuous for any great distance and do not appear to show very great displacements. On the face of one canyon promontory, approximately east of Electra Peak, at least three fault planes can be distinguished, one above another. They conform in strike and dip with the bedded slates and meta-volcanic rocks which have a strike N. 20° to 30° W. and dip 30° to 50° to the southwest. A complex system of inward dipping and vertical fractures occur between thrust planes and clearly indicate that the upper rocks have been thrust over the lower rocks but the displacements do not seem to be great.

In the North Fork Canyon, directly east of the junction of Bench Creek, two prominent and highly-dipping planes of movement can be seen on the steep and rugged eastern wall of the canyon. Although they can not be traced and connected with any certainty with the thrust planes to the north, they are, however, closely aligned with the low-angle thrusts. These planes of movement conform roughly with the general rock structure and dip from 50° to 70° to the southwest. An intense fracturing is common along the fault planes which occur in meta-volcanic rocks. As in the case of the thrusts, the reverse faults have resulted from the waning period of compression which produced the folding, possibly due to the invasion of the granitic rocks. These movements occurred at the limb of a fold rather than at a crest and the maximum displacement has probably not been greater than a thousand feet.

True cross-faults are much fewer in number and only a few of importance were noted. One of these offsets is in the mineralized limestone in the upper Shadow Creek.

Jointing

Jointing is prevailingly well developed in the rocks of the Minaret region. This is especially true of the granitic and the more massive-appearing metamorphic rocks of the Ritter Range. In the highly schistose types, jointing is less common. There are generally three systems developed but commonly one or even two of the systems may be rather weak or wanting. As a general rule, one system strikes in a north-northwesterly direction, while the other system is approximately at right angles to it. Both have a vertical or nearly vertical attitude. A third set usually strikes in a northwesterly direction and dips at a moderately low angle.

In the granitic types, the three systems of jointing are normally present. Although these show a somewhat general relationship in different localities, there is considerable deviation. These joint systems were probably due to regional tensional forces which accompanied the later uplift and unloading of the region. The following table gives some idea of the attitude and nature of the joint system:

JOINT SYSTEM

(V = Vertical)

Locality	*Rock*	(1)	(2)	(3)
Island Pass	Granite	N. 50° E.-V.	N. 30° W.-V.	N. 50° E.-30° NW.
Red Top Mt.	Granite	N. 20° E.-V.	N. 65° W.-V.	------------
Minaret Creek	Granite	N. 65° E.-V.	N. 25° W.-V.	------------
Iron Creek	Peg. Granite	N. 85° E.-V.	N. 10° W.-V.	N. 5° E.-40° SE.
Bench Creek	Granite	N. 75° E.-V.	N. 25° W.-V.	N. 15° E.-20° SE.
Fernandez Pass	Granite	N. 30° E.-V.	N. 40° W.-V.	------------
King Cr.	Diorite-Porphyry	E.-W. V.	N.-S. V.	N.-S., 50° E.

Jointing in the metamorphic rocks is best developed in the more massive rocks composing Ritter Range and generally only one system is well developed. This system usually strikes from N. 30° to 40° E. and dips from 75° SE. to the vertical and is the most pronounced structural control in the formation of the sharp and rugged Minarets. The second system which is approximately at right angles (N. 80° W.) to this is not so well developed.

The various joint systems have been a most important factor in the erosion and removal of material. Great talus accumulations have resulted from the agents of erosion, controlled by jointing in the rocks. In some localities, leaching is common in the rocks along joint planes.

SUMMARY OF GEOLOGIC HISTORY

In so far as the rocks of the Minaret region are concerned, the record of the geologic history begins with a middle Triassic sea into which sediment and volcanic material were deposited. The greater bulk of the material was volcanic tuffs derived from offshore submarine explosions of great violence. Submarine flows accompanied the volcanic activity but these were far less frequent. During periods of quiescence, marine clay and lime were deposited to make up the sedimentary material interbedded with the volcanic material. The deposition continued through the upper Triassic and into the lower Jurassic with general marine conditions prevailing. It is possible that oscillations of the sea floor may have brought the deposits above sea level at different times but not for any great period. The marine conditions of deposition generally appear to have been not far offshore, as shown by the nature of interbedded sediments. In the upper Jurassic the marine deposits began to be warped and towards the close of the Jurassic they had been folded in the earth's crust sufficiently to result in cataclastic and dynamic metamorphic effects. This action resulted in a series of folded mountain ranges which trended in a northwest to southeastern direction. At the close of the folding, granitic magma welled up from below and intruded the metamorphosed sediment and volcanics, giving the present Sierra Nevada batholith. This took place during late Jurassic or lower Cretaceous. Following the invasion, this portion of the earth's crust was subjected to a series of warpings and vertical uplifts followed by a relatively long period of stability near the close of the Tertiary. A westerly drainage was established which eventually developed a broad valley topography. Most of the overlying metamorphic rocks were removed, leaving an occasional roof pendant in the prevailing granitic rock. Near the close of this period of stability, volcanic activity began. Extensive basic flows poured forth over much of the region. At the close of the Tertiary, a block of the earth's crust was elevated greatly along the eastern margin to mountainous height and was the forerunner of our present Sierra Nevada. This uplift ushered in vigorous stream erosion and eventually a new drainage was established. At the end of the Pliocene, a second strong series of uplifts occurred which lifted the Sierra Nevada to about the present height and deep V-shaped canyons resulted from the stream erosion. A period of glaciation followed in the Pleistocene and mountain glaciers advanced and retreated several times. As a result, the landscape was sculptured into a glacial topography. Before the last advance of ice, there were minor outbursts of volcanic activity which gave forth basic flows. After the final retreat of the ice, pumice was scattered over the eastern portion of the area as the result of outlying volcanic activity. Postglacial time has resulted in slight stream-cutting and deposition with minor crustal disturbances.

PHYSIOGRAPHY

The physiographic features are classed into the following zones which can be correlated closely with those found elsewhere in the Sierra Nevada:[12] (1) the High Mountain zone, (2) the High Valley or Mountain Valley zone, and (3) the Low Valley or Canyon zone.

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[12] Lawson, A. C., Geomorphology of the Upper Kern Basin: Cal. Univ. Dept. Geology Bull., vol. 3, pp. 291–376, 1904.

Matthes, F. E., Geologic history of the Yosemite Valley: U. S. Geol. Survey Prof. Paper 160, 137 pp., 1930.

High Mountain Zone

The High Mountain zone consists of two units which include the Sub-summit or Broad Valley plateau and the Summit Upland. The Summit Upland composes a very small portion of the region and includes the peaks, summit crests, and their immediate flanking slopes which rise with more or less uniform slope above the generally even table-surface designated as the Broad Valley plateau. As there is no sudden break in slope between the summits and the plateau, it is difficult to determine where one ends and the other begins. Arbitrarily, the average lower limit of the Summit Upland is from 9000 to 9500 feet elevation, although it may range from 8000 feet to the south to 10,000 feet or more to the north. As such, the Summit Upland would include only the upper reaches of Ritter Range, Merced-San Joaquin Divide and portions of Sierra Crest composed of pre-Tertiary rocks.

Broad Valley Plateau

The Broad Valley Plateau is the old valley equivalent in age to the Summit Upland and is a somewhat even or undulating surface out of which the summit areas rise abruptly. As such, the plateau is by no means a continuous surface but is represented rather by large remnant segments rising back from the brinks of canyons and main hanging-valleys and is best developed in the areas of granitic rock. In some cases erosion has cut back until the plateau surface is represented merely by the crest of a divide. It is the ultimate cut surface of ancient drainage system determined by a long and gradual series of earth movements and upwarpings before late Tertiary time. As the folded mountains of Cretaceous time were removed and the underlying granite was exposed, the southeastern longitudinal drainage was changed to conform with the western tilting of the Sierra block. A long period of stability marked the close of this period which allowed the westerly seeking streams to cut back extensively and establish broad valley floors. Volcanic activity burst forth at different centers and sheets of basic lava issued forth over the old erosion surface. These flowed in the direction of the general southwest drainage over the broad valley surface. The thickest and most extensive lavas which belong to this period of activity cap the crest of the Sierra between the Minaret Summit and Agnew Pass and compose Mammoth Mountain. It has been suggested that the relatively low portion of prevolcanic rock surface of the Sierra Crest in this region may represent a basin of great antiquity which was formed by an ancient large fork of San Joaquin River that drained from the northeast and was cut off by subsequent uplifts of the Sierra block in the late Tertiary.[13] Thus, the lavas may have flowed down an ancient drainage basin, accumulated to great depth and were later uplifted with the beheading of the drainage. It has also been suggested that faulting may be a controlling factor in the formation of the low portion of the divide.[14]

With a strong uplift of the range in late Tertiary, the drainage was adjusted, stream erosion was accelerated, and the lava flows were largely removed leaving remnant cappings upon the old erosion surface of granite and metamorphic rocks. Remnant portions of the Broad

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[13] Matthes, F. E., The Devil's Postpile and its strange setting: Sierra Club Bull., vol. 15, pp. 1–8, 1930.

[14] Mayo, Evans B., Oral communication.

Valley Plateau can best be seen in the region of granitic rocks ranging from 7000 feet in the south up to 9500 feet or greater in the north. The bench-like surface just west of the Mammoth Crest, and the continuation across Middle Fork Canyon to the south slope of Iron Mountain and across North Fork Canyon to Clover Meadow flats, forms the largest remnant of the Broad Valley erosion surface. The identity of this surface in the metamorphic rocks is not so apparent because of the higher resistance of erosion in these rocks.

High Valley Zone

As already stated, the very late Miocene or early Pliocene uplift of the Sierra Nevada block vigorously accelerated stream erosion and began a down-cutting into the Broad Valley surface. The configuration of this consequent drainage was controlled largely by the main features of the earlier drainage, but not until after the last great uplift did the present drainage pattern come into its present detailed configuration. The streams entrenched themselves into deep narrow canyons which gradually grew to deep, broad, V-shaped valleys. The major streams eroded relatively greater than did the tributary streams and, as a consequence, the valleys of the latter were left 'hanging' above the main river-cut gorges. The relative cutting and erosion power of the major streams to the minor streams is dependent, however, on several factors. Besides the relative volume of water and the resistiveness of the bed rock, there is the relation of the stream course to the tilt of the range. In this respect, the more easterly tributary streams of the North and Middle Forks of San Joaquin River should be less 'hanging' than the western but it will be noted that this is not always the case. Thousand Island and Garnet Lake basins 'hang' relatively high because they consist of small watersheds occupied by large lakes, and stream erosion has not been favored by uplifts of the range. Also the rocks in these basins are resistant types. Shadow Creek basin is relatively lower because the basin is larger and stream erosion has been more effective in down-cutting. Minaret and King Creeks have a similar general drainage relation, yet they have succeeded in cutting down considerably more. This is due to the fact that they are both large streams and flow principally over granitic rock which is more easily eroded than the more resistant metamorphic rocks. Further, they seek a southern trend which tends to steepen their gradients. Crater Creek, Stairway Creek, and Cargyle Creek basins are 'hanging' because the streams are far smaller than the river and have not been as effective in erosion. In the North Fork basin, the smaller basins of Iron and Dike Creeks are not strictly 'hanging valley' types because their streams are relatively large and their gradients effectively steepened by the uplift of the range. Bench Canyon and Long Creek basins are 'hanging' principally because their gradients were not steepened by the uplift of the range. No long period of stability existed following the first uplift, as compared with that of the late Tertiary, hence the streams merely formed a system of V-shaped channels of moderate depth and of no appreciable width. They had not effectively completed degradation when the most important uplift accelerated stream erosion which began an effective down-cutting, resulting in the development of the last important physiographic feature, the major canyons.

Canyon Zone

The last major uplift of the range, in late Pliocene, or early Pleistocene, caused important stream erosion prior to glaciation. The major streams eroded to the extent that they succeeded in deepening their V-shaped channels to nearly their present depth. The tributary streams lowered their channels to a much lesser degree. Erosion continued until interrupted by the occupation of the ice during the Pleistocene. As the region became ice-ridden, the topography was modified. Canyons and 'hanging valleys' were rendered U-shaped and ridges were rounded.

Glacial Features

The ice of the Pleistocene glaciation was generated in the mountainous region as the result of snow accumulation over a long period. An extensive system of mountain glaciers were formed which radiated from the higher areas and flowed down to the lower altitudes. The principal glaciers generally occupied the main river canyons, while feeder branches occupied the tributary stream basins. Only the higher peaks and crests as found in the upper reaches of Sierra Crest, Ritter Range, Volcanic Ridge, and the Merced-North Fork divide, projected above the ice mantle.

There is evidence that the glaciers advanced and retreated at least twice, and possibly a third or fourth time,[15] during the general period of glaciation. The maximum lower limit of each advance of the San Joaquin trunk glacier was well beyond the Minaret region. It is probable that the interglacial interval was several times as long as any one glacial period.

Besides the general glacial sculpture of the landscape, there is further evidence of ice occupation over nearly the entire region. This includes irregular morainal deposits, erratic boulders, glacial polish and other such markings. Well preserved, high-crested moraines are generally lacking, with exception of those on the bench south of Iron Mountain. Earlier moraines have been largely removed by post-glacial stream erosion. Recessional moraines of recent date are common in the heads of the hanging valleys where they often impound water, giving morainal lakes. A few small glaciers still exist on high and well protected situations, as on the east slope of the Minarets and about Mt. Ritter and Banner Peak.

Post-Glacial Features

With the final disappearance of the Pleistocene glaciers, stream erosion and weathering processes again become important agents of degradation. The rivers and major tributary streams began to cut narrow channels along the steeper portions of their courses and to deposit sediment and impound waters in the flatter or ice-gouged basins. The post-glacial cutting and deposition has been sufficient to give narrow channels up to a hundred feet or more in depth and flats over several acres in extent. Upon these flats, the streams generally meander as a temporary base level has been reached. Some of the cutting and sedimentation may also have been due to the action of sub-glacial streams. In the higher areas, glacial lakes or tarns are exceedingly abundant features of the drainage systems. These are due to the filling of a glacial cut basin or by the impounding of water back of recessional moraines. Some of the lakes are very large and offer beautiful additions to the mountain landscape. A few large meadows exist on the flats along the major streams as above Shadow Lake, the lower Minaret Fall and at Agnew Meadows, Soda Springs and Pumice Flat on the Middle Fork.

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[15] Blackwelder, Eliot, Pleistocene glaciation in the Sierra Nevada and Basin ranges: Bull. Geol. Soc. Am., vol. 42, pp. 865–922, 1931.

The weathering of the general rock surfaces in this high mountain country is accomplished by mechanical disintegration, as well as by abrasion due to rain wash and glacial and stream erosion. The granitic rocks have perhaps suffered most from rock disintegration and exfoliation. Coarse gravel sands and sheeting structure have developed at different localities. Dome-like forms as Cattle Mountain, The Balls, and minor promontories are due to the peeling off of granite sheets by exfoliation. Jointing is well developed in the rocks and it has effected weathering, causing the development of considerable talus to be formed at the foot of the steeper canyons and cirque walls. Pumice, which was thrown out by volcanic action after the retreat of the ice, is to be found mixed abundantly with the normal materials of erosion.

ECONOMIC GEOLOGY

General Statement

The various ore-deposits of the Minaret Mining District represent mineralization of the same general period. This period was post-granitic and pre-volcanic. As the deposits occur in a high mountain region which has recently been glaciated, the ore is largely of primary character and shows very little oxidation. The ores are essentially base metal and include principally those of iron, lead, zinc, copper, and silver, with minor amounts of molybdenum, tungsten, and bismuth. Among these, iron, lead, zinc, and silver are most abundant, while the rest are generally subordinate. The deposits are grouped into the following classes on a basis of the dominant metal or metals present. The larger or more extensive occurrences include (1) iron, (2) lead-zinc, and (3) silver, while the minor deposits include (4) copper, (5) molybdenum, and (6) tungsten.

The magnetite deposit on the west slope of Iron Mountain constitutes the most important known occurrence of ore in the Minaret region.[16] The principal deposit occurs as a somewhat massive and elongated body near or on the contact of granitic and meta-volcanic rock. The longer dimension of the outcrop is roughly 500 feet in extent and generally conforms with the northwest strike of the metamorphic rocks. The ore forms large masses and veins in the metamorphic rocks and small veins or disseminations in the granitic rock. The magnetite is non-titaniferous and approximately four to five million tons are available.

The lead-zinc deposits fall into two classes which include the deposits associated with limestone and those forming vein deposits. In the former, the ore consists principally of silver-bearing galena with sphalerite and admixtures of chalcopyrite and pyrite. The ore occurs as irregular masses, lentiles, veinlets and disseminations in a highly altered limestone which is interbedded with meta-volcanic rocks. The alteration of the limestone with the development principally of epidote, garnet, and actinolite, preceded the mineralization. The ore was deposited along premineral fractures, showing some replacement. The chief values are confined principally to a variable silver content in galena. Deposits of this class are found in the upper Minaret and Shadow Creeks.

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[16] Weeks, F. B., The Minaret iron deposit: State Mineralogist's Report XIV, State Mining Bureau, pp. 555–558, 1915.
Dougherty, E. Y., Magnetite deposits of Madera County, California, constitute important reserves: Eng. Min. Jour., vol. 123, pp. 765–770, 1927.

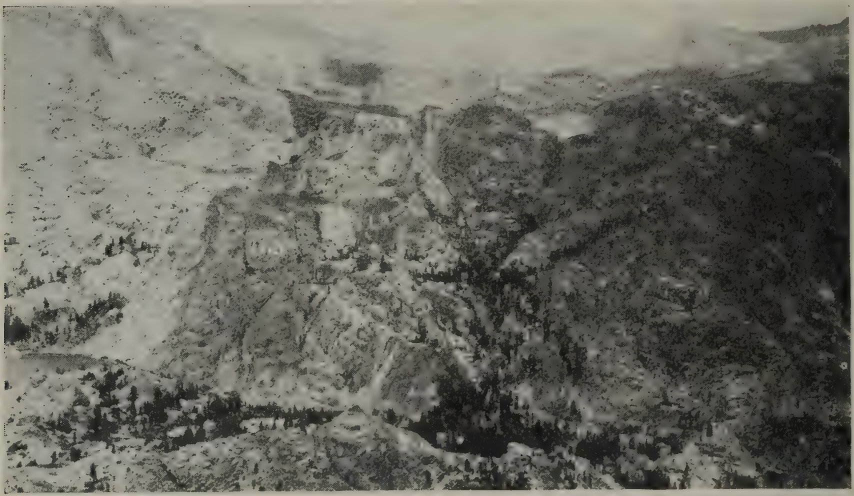

FIG. 33. The Upper North Slope of Shadow Creek Canyon from Volcanic Ridge. Rv—Ritter meta-volcanic rocks, Dio—diorite porphyry, Mv—metamorphosed volcanics, LS—limestone.

The true vein deposits of lead and zinc are of lesser extent. In these, galena and sphalerite occur chiefly in quartz veins and stringers in the metamorphic rocks which conform generally with their strike. This includes the mineralizations in the vicinty of Agnew Meadows, Minaret Summit, and the upper North Fork basin.

A silver-bearing deposit is found about two miles northwest of Agnew Meadows. This deposit includes a silver-bearing lead-bismuth ore along with chalcopyrite, pyrrhotite, and sphalerite. The ore occurs in quartz veins and veinlets near or on the contact of a metamorphosed rhyolitic tuff and slate.

Lesser deposits include copper as chalcopyrite in upper King Creek, tungsten as wolframite in upper Iron Creek, and molybdenum as molybdenite on the east slope of Red Top Mountain.

Iron Deposit

The only economic occurrence of iron ore in the Minaret region is found at 10,500 feet on the apex of a ridge on the west slope of Iron Mountain which rises 11,157 feet in elevation. This deposit is reached by trail from '77 Corral, about four miles south of the mountain on the Mammoth Trail. It has been described in early reports of the California State Mining Bureau.[17]

The geology of the deposit includes granitic and metamorphic rocks and the main orebody is closely associated with the contact. The granite is a fine-grained alkali granite with hornblende as the chief mineral. It is genetically related to the micropegmatitic granite of the Iron Creek basin. A thin section of the rock, which was intimately lined with magnetite, revealed essentially a graphic intergrowth of quartz and orthoclase with a small amount of oligoclase feldspar. The rock is later than the more basic intrusive rocks which are generally in immediate contact with the metamorphic rocks of Iron Mountain on the north, west, and southwest slope. Throughout its occurrence, the granite shows considerable strain effects. In one case, southeast of the main body of ore, the rock has been intensely shattered and penetrated by rock material of similar composition which, in turn, is cut by numerous small veins of magnetite ore.

The metamorphic rock in the immediate vicinity of the iron deposit was derived largely from volcanic flows and tuffs. A specimen taken from the summit of the mountain showed a rather dark blastoporphyritic rock of andesitic composition. Near the granitic and ore contact, the rock shows a higher degree of schistosity. The metamorphic rocks vary considerably as to field appearance, giving various light to dark members.

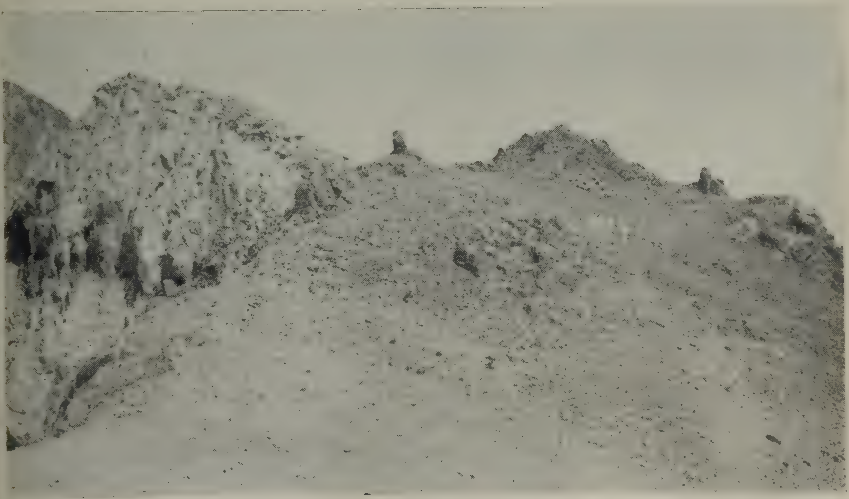

FIG. 34. Outcrop of magnetite (Mag.)—on Iron Mountain micro-pegmatitic granite (Gr.) lies in the foreground with the schist beyond the magnetite. Iron Mountain on left.

The igneous contact in the vicinity of the magnetite deposit generally conforms with the strike of the country rock which is N. 40° to 45° W. At the magnetite deposit, a lobe of the granitic rock extends out from the general contact and the ore is found at the apex.

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[17] Watts, W. L., Fresno County, The Minaret iron mines: California State Min. Bur. Eleventh Ann. Rept., p. 214, 1893.
Goldstone, L. P., Fresno County, Iron: California State Min. Bur. Tenth Ann. Rept., pp. 191–193, 1890.

The main occurrence is a massive but elongated body of ore occurring in the metamorphic rock in close association with the granitic rock. The surface outcrop is about 500 feet in length and nearly 100 feet in maximum width. The massive body gradually terminates to the north and south where the ore passes into tabular deposits which conform to the strike of the metamorphic rocks and finally thin out. This is especially true of the north extension where the deposit has been cut away by the action of the ice and exposed on a cirque wall. In the more massive portion of the ore, there is merely an occasional fragment of preexistent rock which indicates almost total replacement of the rock by the ore. In the granitic rock proper, there are no large bodies of magnetite, but locally there are numerous small bodies of ore. These do not extend far into the granitic body in west and southwest directions. East and southeast of the main orebody for some distance there are numerous small masses, stringers, and disseminations of ore both in the metamorphic and granitic rocks. Dark basic dikes intrude both rock types and appear to be cut off by the ore. These dikes strike in a northeasterly direction and vary from less than a foot to five feet or more in width. This is some evidence that the ore may be, in part, contemporaneous with the intrusion of the dikes.

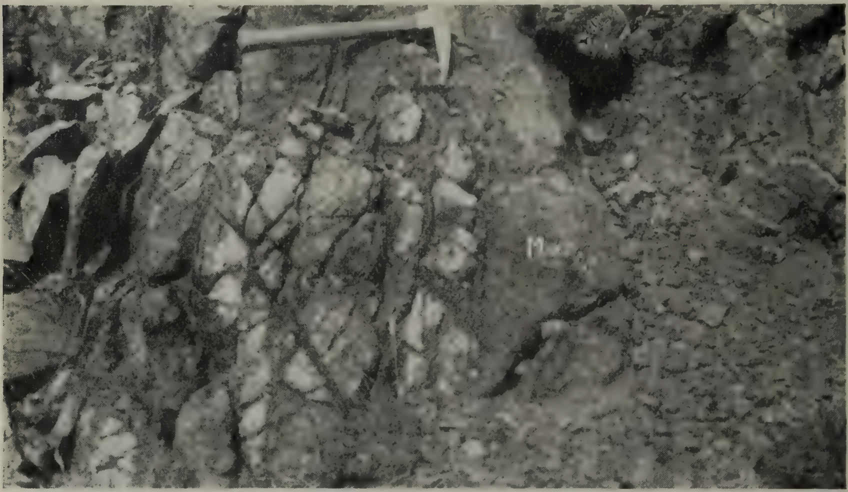

FIG. 35. Magnetite veinlets (Mag.) cutting the micro-pagmatitic granite (Gr.).

The magnetite is generally finely crystalline but occasional large octahedral crystals can be seen. In places, the dense brownish-black ore contains abundant plagioclase feldspar. The feldspar crystals are earlier than the magnetite as they have been broken and penetrated by the ore. Veins or dikes of feldspar and actinolite, ranging from several inches up to a foot or more in width, cut the massive magnetite in a few places. The actinolite generally forms large prismatic crystals along with feldspar and gives a banded appearance with the longer dimension of the crystals normal to the walls. These may be, in part, contemporaneous with the formation of the ore. A late generation of magnetite also occurs in the veins which cut the more massive and apparently earlier crystallized magnetite. In places, a short distance from the massive orebody, irregular masses of actinolite and magnetite occur. In these, actinolite forms large radiating crystals up to half a foot in length, with the magnetite present in patches through the mineral mass. The actinolite shows the common light-green color but probably contains some iron as shown by the presence of oxides from weathering of the mineral. Hedenbergite, phlogopite, and epidote are present in minor amounts along with actinolite and feldspar. The magnetite is generally unaltered and presents a uniform dark brownish-black appearance.

The ore consists of common magnetite (Fe_3O_4), but no titanium is reported from analyses. This seems remarkable where the accessory magnetite in the outlying granitic rocks is generally titaniferous. Silica, phosphorus and sulphur have been reported in small amounts from the chemical analyses. A bluish staining is present in several places and probably indicates the presence of copper.

From all field relations, this deposit of ore appears to be a magmatic deposit. The massive orebody passes into large ore dikes in the direction of the longer dimension of the orebody. These dikes have been injected along the schistosity of the metamorphic rocks and there is an absence of any original vein material, with considerable shearing and strain effects upon the immediate wall rock. The presence of large crystals of actinolite and feldspar which cut the magnetite, indicates the presence of mineralizers derived from a wet magma below.

The amount of ore that can be recovered profitably is difficult to ascertain, but it is certain that the deposit has sufficient reserves to form an important source of iron ore in the future. Various estimates, both conservative and exaggerated, have been made from time to time regarding the possible amount of ore that could be recovered from the deposit. Among the more conservative figures the amount of ore in sight is estimated from five to ten million tons of which there is at least twenty per cent impurity.[18] The lesser figure seems the most likely. The exploitation of this deposit is not an immediate demand, when the inaccessibility is considered together with the general low market price of iron which requires large-scale operations and the lack of satisfactory reduction facilities on the Pacific coast.

Lead-Zinc Deposits

In the lead-zinc mineralization, two classes of deposits have been recognized: those deposits which occur in limestone, and those which form true vein types. The deposits in limestone are the most important.

The deposits of this class are found principally in the basins of Shadow and Minaret Creeks. The Shadow Creek deposits consist largely of primary lead and zinc ores in an altered limestone member, while the Minaret Creek deposit consists largely of lead ore. Both of the deposits carry silver and copper values.

On the north side of the Shadow Creek basin, near the summit of the Shadow-Garnet Divide, a prominent outcrop of ore is found which consists essentially of sphalerite, chalcopyrite, and galena in a highly altered limestone. The limestone member is from 100 to 150 feet wide, and has a strike of N. 25° to 35° W., and a vertical dip. Interbedded with the limestone on either side are generally metamorphosed rhyolitic tuffs and flow rock. A dark-green diorite porphyry-intrusive crops out a short distance west of the limestone and parallels this member, more or less, throughout its surface exposure. Although the limestone is extensively altered, the original bedding and parting-structure is commonly preserved. This is especially true where epidote and garnet are the important minerals to have been developed, resulting in a greenish and brownish banded-appearing rock. Where actinolite is abundant, the original character of the rock is entirely lost as a much coarser grade of crystallinity is normally present. Alteration to the silicate minerals has been somewhat selective and relatively unaltered patches of crystalline limestone frequently occur. Veinlets and drusy cavities of quartz are commonly scattered throughout the rock. Garnet and epidote are common with the quartz.

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[18] Dougherty, E. P., *Op. cit.*

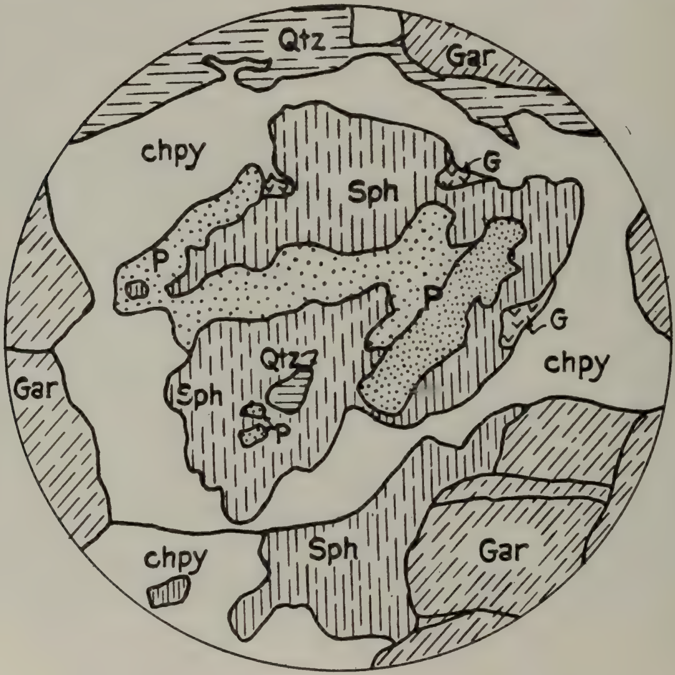


FIG. 36. Micro-sketch showing ore-texture from a lead-zinc limestone deposit. Note sequence of pyrite (P) in center, with sphalerite (Sph) next, followed by galena (G), and chalcopyrite (Chpy), last. Other sulfides not shown. 50 X.

The ore consists of an iron-bearing variety of sphalerite (black jack), chalcopyrite, pyrite and galena which carries silver. The zinc mineral is most abundant on the north side of Shadow Creek, with chalcopyrite and galena subordinate. The ore occurs generally in a somewhat large and irregular mass and as lenses, kidneys, rude veins, and disseminations through the altered limestone. Oxidation of the primary minerals has been slight and only a small amount of staining occurs in the copper ores. Some anglesite occurs in the lead ores.

On the south of Shadow Creek canyon, between the creek and the top of the divide, there are several small outcrops of ore which consist essentially of silver-bearing galena with a lesser amount of pure sphalerite, and chalcopyrite. The ore is disseminated or forms veinlets through a crystalline limestone in which relatively little alteration to silicate minerals is found. Locally, however, patches of epidote, garnet, and rhodonite occur. The member varies from 150 to 200 feet in width, and generally the original bedding-structure is preserved. The meta-volcanic rocks are in contact with the limestone. High on the south wall of Shadow Creek, limestone is in contact with a diorite porphyry intrusion.

In Minaret Creek basin, there is one prominent occurrence of ore on Johnston Creek at about 10,000 feet. This deposit lies in the continuation of the same limestone which is host to the Shadow Creek deposits. In this vicinity, the limestone is crystalline with the bedding structure generally well preserved, and has undergone little alteration to silicate minerals. Of the new minerals developed, epidote is the most common with small amounts of actinolite and tremolite. At the Minaret Mine, the limestone ranges from 200 to 300 feet in width, strikes N. 40° to 45° W. and dips from the vertical to 80° northeast. In immediate contact with the limestone are metamorphosed rhyolitic crystal tuffs with the diorite porphyry intrusion very near to the west. Basic dikes which range up to several feet in width are intrusive into the limestone.

The ore of the Johnston Creek deposit consists of argentiferous galena with some chalcopyrite and pyrite, but sphalerite is absent. The limestone has a peculiar dark-brown to blackish appearance which is due to iron and manganese oxide staining. The ore occurs as irregular patches, lenses, and disseminations controlled by pre-mineral cross-fractures in the limestone. The most important controlling factor in the mineralization has been the intersection of pre-mineral cross-faults with the bed and parting structure of the limestone.

Epidote is the most abundant silicate mineral to be developed in the limestone. It likewise has widespread occurrence in other rocks and appears to have been developed under various conditions. It is the characteristic common yellowish green variety and generally finely crystalline, except along bedding planes and in cavities where crystals range up to several millimeters in length.

Garnet is of the lime-alumina variety known as grossularite. This is intimately associated with epidote and is next in relative abundance. It exhibits a light cinnamon to dark reddish-brown color showing profound crystal development but generally finely crystalline. Crystals up to a centimeter in diameter are common with epidote and quartz as aggregates along bedding surfaces and as lining in cavities.

Actinolite is abundant in several localities although it is not so wide-spread as the epidote and garnet. It is a light-green mineral with profound prismatic development and marked amphibole cleavage. In places, it forms massive aggregates in which individual crystals range up to five or six inches in length.

Tremolite is rather scarce and forms small radiant aggregates of white mineral along bedding planes in the limestone.

Quartz is abundant as a late mineral in the altered limestone. It varies from a clear to whitish color, with crystals varying from fine to several centimeters in length. Veinlets of white quartz cut at random the garnet and epidote rock. Large and clear quartz crystals are common in cavities along with garnet and epidote forming drusy linings.

Pyrite is the most common and persistent of the metallic minerals although not the most abundant. It is pale-brass in color and generally forms rather fine grains or aggregates and cubes which range up to nearly a centimeter in size in with the other sulfides.

Argentiferous galena is quite persistent, fairly abundant and perhaps the most important ore mineral as it holds the silver values. The galena is generally fine to medium-grained, coarsely crystalline and presents the usual prominent cubic cleavage. It occurs scattered or in large crystalline masses along with other sulfides forming the ore. The mineral is commonly altered slightly to anglesite on weathered surfaces.

Chalcopyrite is quite persistent but not exceedingly abundant in any one place. It presents the common brass-yellow appearance and is intimately associated with galena either as scattered grains or in large aggregates. A blue iridescence gives the mineral the appearance of bornite staining. Slight amounts of malachite and chrysocolla originate from the chalcopyrite.

Sphalerite, being somewhat variable in distribution, also varies considerably as to composition. This includes the iron-bearing variety or black-jack and the pure variety known as resin-jack. The latter is most abundant and occurs principally on the north side of Shadow Creek while the former is more or less evenly distributed throughout the ore. The impure mineral is of brownish-black appearance and rather coarsely crystalline while the purer variety is yellow-brown and of finer crystallinity.

As few figures are available and the deposits are quite variable, no definite grade of ore can be stated. On the north side of Shadow Creek the zinc ore is said to run as high as 60% zinc which includes the only known deposit here. On the south side of Shadow Creek, the ore is exposed in several places and is stated to average one ounce of silver to each percent of lead. Occasional shoots show silver values up to 50 and 60 ounces per ton.

On Johnston Creek, assays taken at the collar of the shaft showed 42.5% lead, 37 oz. silver, 9.11% zinc, and 3.68% copper across 18 inches. Samples taken across a 250-foot width of ore zone, south of the shaft, averaged 1.5% lead and 1.5 oz. silver.

Several polished surfaces of ore from the north side of Shadow Creek showed some interesting mineral relations. The gangue consists essentially of quartz and garnet of which there has been two generations of the former and one generation of the latter. Quartz is included as distinctly angular fragments in garnet which is, in turn, automorphic to later quartz. Through fragmentary grains of gangue pyrite is scattered which represents the earliest of the sulfides.

his is shown by the fact that it has been badly broken, penetrated, nd embayed by the later sulfides. Intimately associated with the yrite is sphalerite. This mineral forms veinlets and irregular patches hrough the pyrite and early gangue and is earlier than the chalcopy-ite or galena. Following the pyrite and sphalerite, chalcopyrite and alena were introduced. These two minerals occur as minute veinlets nd patches which penetrate all of the foregoing minerals and probably re contemporaneous in formation. From the ore textures, it follows hat there has been a definite order of formation. First, there has een the alteration of the limestone which includes silicification and arnetization and the later introduction of the sulfides in a definite rder. In the specimens observed quartz was developed first. This as shattered and chalcopyrite and galena were introduced nearly imultaneously.

The lead-zinc deposits were formed by the action of hot ascending olutions of igneous origin which deposited their metallic load in a reviously altered limestone. The solutions which altered the lime-tone were of the same origin but antedated that of the metal-bearing olutions. It is difficult to say to what igneous body the deposits are enetically related. The nearest igneous rock is a large body of iorite porphyry which is oldest of the intrusive rocks. The deposits re younger than this rock. Deposits of lead and zinc, in the North ork basin, are found cutting the micropegmatitic granite which is the atest of the intrusive rocks. It therefore seems that these deposits ere formed later than the main types of granitic rocks. The lime-tone alteration includes the development of garnet, epidote, actinolite, remolite, diopside, and quartz. From a comparative study of the omposition of the altered and unaltered limestone, it appears that ppreciable amounts of silica, alumina, magnesia, iron oxides, and ater were added to the limestone to produce the above minerals. This lteration was completed before the introduction of the principal sul-des, and there is reason to believe that the latter were deposited hrough fracture-filling and that replacement played only a subordi-ate role. The ore in the limestone appears to be localized in and ear fracture zones of faults which cut across the bedding. The sul-ides were introduced in a definite order with the iron and zinc minerals rst followed by the later lead and copper minerals.

In age, the deposits are post-granitic and pre-volcanic, which ould place them somewhere between early Cretaceous and late Mio-ene. The ores are later than the finely-crystalline, basic dikes which ut the limestone, which may have possibly been formed in the early Tertiary or late Mesozoic.

Further search for ore should be directed along pre-mineral cross-aults and buckling in the limestone. Such faults would cut the lime-tone but not the nearby diorite porphyry intrusion, as the metalliza-ion was later than the intrusion.

Vein deposits of lead and zinc are not as common as the replacements in the limestones. Deposits of the vein class are found in North and Middle Fork basins. Although they vary considerably in nature from the deposits in limestone, they are regarded as belonging o the same period of mineralization. The zinc values are generally ow while the lead is usually the most important and abundant ore mineral and generally is silver-bearing. Copper is present in small and variable amounts.

In North Fork basin, the deposits on the Burris and Bliss properties are the most important. On the Burris property the ore is confined to small vertical parallel quartz veins which strike about N. 60° W. These occur at an elevation of about 9300 feet in the upper North Fork basin, where they cut a small area of creamish-brown, micro-pegmatitic granitic rock that is intrusive into the meta-volcanic rock and diorite porphyry. The veins range from narrow widths up to a foot or more and carry argentiferous galena, sphalerite (blackjack), chalcopyrite, and pyrite. Native gold has been found in galena ore from these deposits.

The Bliss property adjoins the Burris property on the north. The principal occurrence of ore is found in a vertical vein which has a surface outcrop of about 1500 feet and strikes N. 85° W. The containing walls consist of the meta-volcanic rocks of the Ritter Range. The maximum width of the vein is about six feet and the north wall is the hanging wall. Quartz comprises the principal gangue material while the ore minerals consist principally of argentiferous galena with subordinate amounts of chalcopyrite, sphalerite, and pyrite. Slight surface oxidation has given secondary minerals linarite, malachite, bornite, and anglesite. This exposure lies at an elevation of 9700 feet on a stream draining Davis Lake.

In Middle Fork basin, deposits of this class are found, largely on the east slope of Middle Canyon, between a point north of Agnew Meadows and Minaret Summit. This includes the deposits on the properties of the Agnew Meadows Mining Corp., the Minaret Mining Co., the Herford-Butler group, and others. The deposits consist of quartz stringers and veins carrying argentiferous galena, sphalerite, and pyrite as the ore minerals. The veins generally occur in light-colored schists and cataclastic metamorphic rock and conform with the strike of the schistosity. The veins are not individually large but form a system of stringers which range from 35 to 40 feet in width. Some of the sulphides, notably pyrite, are disseminated in the wall rock some distance from the veins.

Silver-Lead Deposits

The only orebody which may be classified as a silver deposit is the unique mineralization found on the Sullenger property. This lies about three miles northwest of the Agnew Meadows at an elevation of 9500 feet on the east slope of Middle Fork Canyon. The ore occurs in quartz veins, veinlets in a metamorphosed rhyolitic tuff and clay-slate. The vein system ranges over a wide zone but no single vein is more than a foot or two in width. The zone includes parallel strike faults which show considerable premineral movement. The fracturing thus produced has made structure favorable for the deposition of ore. The strike of the veins generally conforms to the northwestern strike of the schistosity and slate-cleavage. A study of several polished surfaces of the ore showed it to consist of pyrrhotite, sphalerite, chalcopyrite, native silver, and a bismuth-bearing mineral. These were introduced by metallizing solutions in the order named.

Minor Deposits

MOLYBDENUM

There is a small occurrence of molybdenite on the west slope of Red-Top Mountain, at an elevation of 9300 feet, on the Minaret-King Creek trail. It occurs in small quartz veinlets in a medium to fine-grained biotite-hornblende-quartz monzonite. Two vertical systems of joints occur. One system strikes N. 20° E. and the other N. 65° to 70° W. The former is stained brown due to the weathering of accessory pyrite. The latter conforms in direction with the quartz veinlets, which are over an inch or two in width. The molybdenite is scattered through the quartz and in cavities. Molybdite is a secondary mineral.

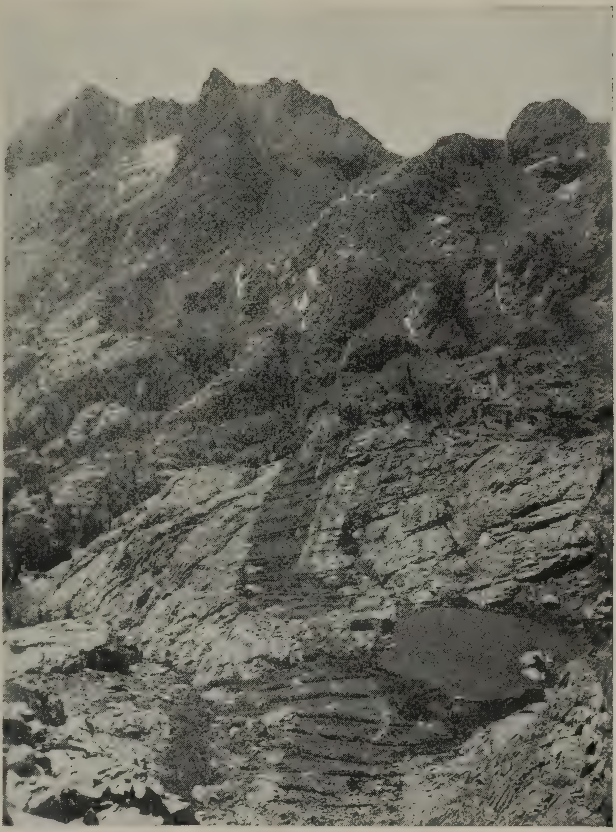


Fig. 37. Mineralized limestone of the north extension of the Nidever property as seen from Garnet Lake Divide looking south to Volcanic Ridge. Note the cross-cut trenches at regular intervals.

COPPER

Near the outlet of Lake Superior, there is a showing of copper ore which consists essentially of pyrite and chalcopyrite. This ore occurs as veinlets and disseminations in a dark, fine-grained metamorphic rock.

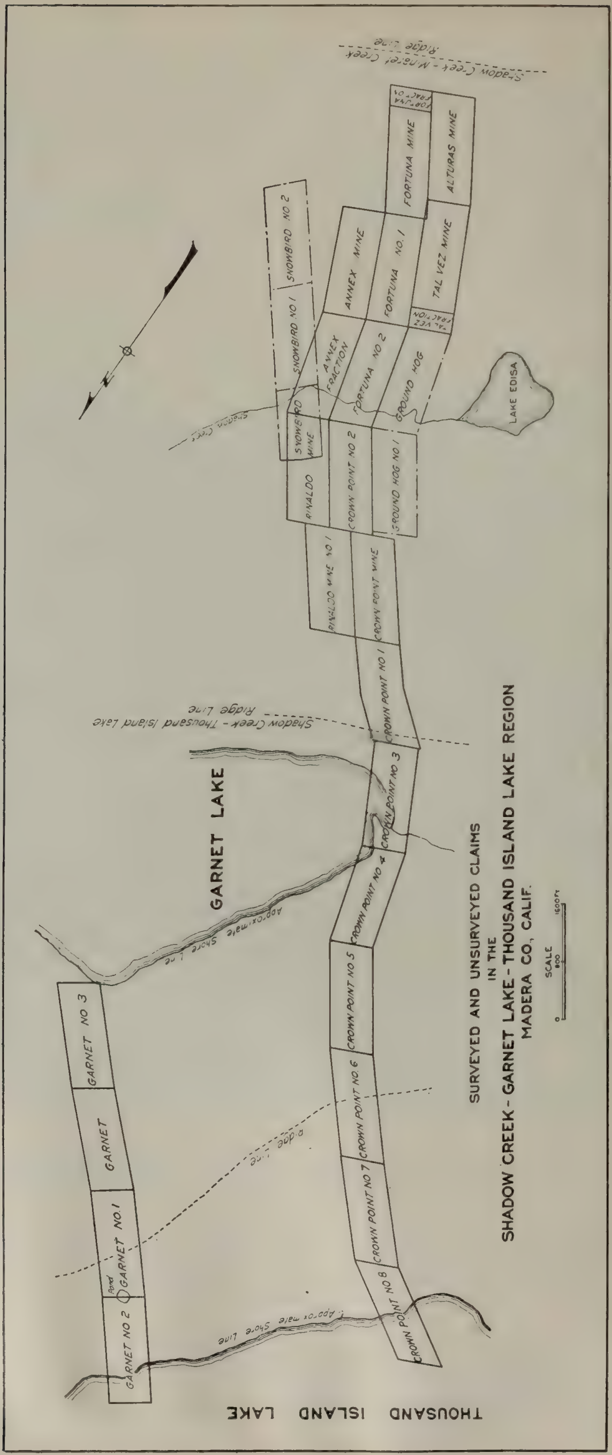

SURVEYED AND UNSURVEYED CLAIMS
IN THE
SHADOW CREEK - GARNET LAKE - THOUSAND ISLAND LAKE REGION
MADERA CO., CALIF.
SCALE
0
800
1600 FT
Shadow Creek - Minaret Creek Ridge Line
FORTUNA FRACTION
FORTUNA MINE
ALTURAS MINE
SNOWBIRD NO 2
SNOWBIRD NO 1
ANNEX MINE
FORTUNA NO. 1
TAL VEZ MINE
TAL VEZ FRACTION
ANNEX FRACTION
FORTUNA NO 2
GROUND HOG
LAKE EDISA
Shadow Creek
SNOWBIRD MINE
RINALDO
CROWN POINT NO 2
GROUND HOG NO 1
RINALDO MINE NO 1
CROWN POINT MINE
CROWN POINT NO 1
Shadow Creek - Thousand Island Lake Ridge Line
GARNET LAKE
CROWN POINT NO 3
CROWN POINT NO 4
CROWN POINT NO 5
CROWN POINT NO 6
CROWN POINT NO 7
CROWN POINT NO 8
Approximate Shore Line
GARNET NO 3
GARNET
GARNET NO. 1
Pond
GARNET NO 2
Ridge Line
Approximate Shore Line
THOUSAND ISLAND LAKE

FIG. 38

Under the microscope, this rock is found to contain abundant green biotite and hornblende and quartzose-feldspathic material. The ore-bearing fractures are vertical and strike in a northerly direction, cutting a system of quartz veinlets which have a northerly strike and dip 40° to 60° towards the west. The chalcopyrite has altered slightly to malachite which gives a bluish-green staining.

TUNGSTEN

A quartz vein outcrops at the head of Iron Creek, 10,700 feet elevation, which carries wolframite. This vein has a northerly strike and dips east, 45° to the vertical, and has a surface outcrop of about 2000 feet. The width of the vein varies from one-half a foot up to three feet or more and occurs entirely in the light, cream-colored micropegmatitic granite. The vein has been severely crushed with development of sericite and fine gouge. Brownish-black wolframite shows good crystal form along with quartz crystals in the center of the vein, while the vein boundaries are generally well crushed. Large cubes of pyrite occur with the wolframite and have been weathered materially, giving a limonitic stain.

Mines and Prospects

Iron Mountain Group

The principal occurrence of iron ore on Iron Mountain is taken up by two patented and eight unpatented claims held by the Noble Electric Steel Company. The two patented claims include the massive occurrence of magnetite which outcrops across the ridge directly west of the main peak summit. The other claims include lesser scattered occurrences of magnetite which lie to the southeast in the metamorphic and granitic rocks.

Only such work has been done as was necessary to keep the unpatented claims valid. This work has been of superficial nature as the property workings consist principally of small open pits and short prospect drifts. A horse trail leading from '77 Corral up to the deposit has been built as part of the necessary development work.

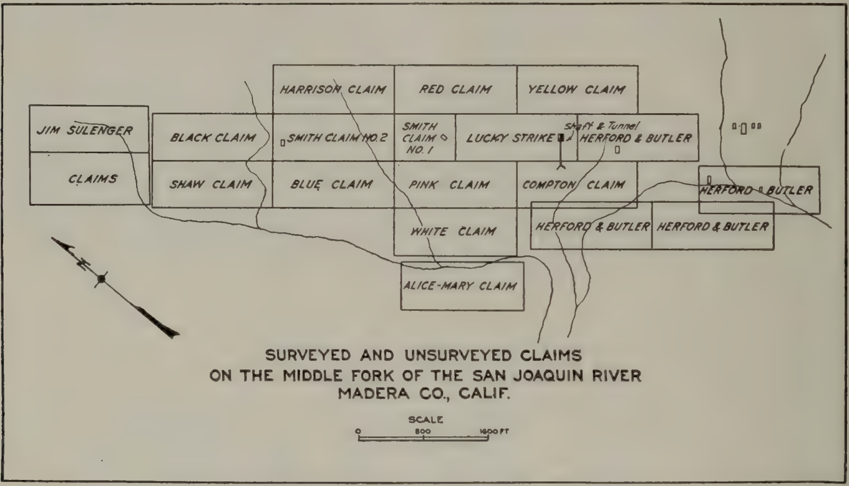
There are numerous other claims which have been located on the south slope of Iron Mountain, but most of them are believed to be invalid at the present time.

Nidever Group

This group includes the 'Mother Lode' limestone in the Shadow Creek basin, and its holders are David C. Nidever, of Bishop, California, and Myron Folsom, of San Francisco. The property consists of nine claims and two fractions, all of which are unpatented. On the north side of Shadow Creek, between the creek and the summit of Shadow-Garnet divide, are the four Crown Point claims. The southern extension of these claims, to the top of Shadow-Minaret divide, is taken up in three Fortuna claims and a fraction. Adjoining these on the west are two Tal Vez claims and fractions.

On the north extension, the principal showing of ore is found on the Crown Point No. 1 and Mine claim. Here the mineralization is strong over a width of 150 feet and runs principally in zinc with lead, copper, and some silver. The outcrop has been extensively trenched by a former lessee and shows good milling values for a horizontal distance of about a thousand feet. Besides the crosscut trenches, there are two diamond drill holes, and a shallow shaft. Below the outcrop, several short drifts have been made.

South of the creek, the values run principally in lead and silver with some zinc and copper. The development work consists of several small open cuts and short drifts.


HARRISON CLAIM
RED CLAIM
YELLOW CLAIM
JIM SULENGER
CLAIMS
BLACK CLAIM
SMITH CLAIM NO. 2
SMITH CLAIM NO. 1
LUCKY STRIKE
Shaft & Tunnel
HERFORD & BUTLER
SHAW CLAIM
BLUE CLAIM
PINK CLAIM
COMPTON CLAIM
HERFORD & BUTLER
WHITE CLAIM
HERFORD & BUTLER
HERFORD & BUTLER
ALICE-MARY CLAIM
SCALE
0
800
1600 FT

SURVEYED AND UNSURVEYED CLAIMS
ON THE MIDDLE FORK OF THE SAN JOAQUIN RIVER
MADERA CO., CALIF.

FIG. 39

Minaret Consolidated Mines Company

The Minaret Mines Company, of which C. C. Randall of Los Angeles is president, holds a group of 34 claims in the upper basin of Minaret Creek on a tributary fork known as Johnston Creek. Although the company had not mined or made any regular shipments of ore, it had made the property accessible, installed equipment and prospected for ore. This included an auto road from Minaret Summit down to Middle Fork River, a tractor road up Minaret Creek to the mine at 10,000 feet elevation on Volcanic Ridge, a 300-foot shaft equipped with headframe and hoist, a considerable number of drifts, open cuts, and trenches, as well as several thousand feet of diamond drill holes, and the building of necessary mine housing.

The company claims run from the summit of Shadow-Minaret divide down to Minaret Creek in a southeasterly direction and are joined on the north by the Nidever claims. The principal showing of ore, thus far located, is on the Albino claim near the shaft.

Adjoining the Minaret Mines property to the east, west, and south is a group of claims held by the National Engineering Company. No mining work has been done on them.

Sullenger (Tom Agnew) Group

This group of eight claims lies northwest of Agnew Meadows and covers the ground originally held as early as the late seventies by Tom

Agnew, a pioneer. The present holder is J. R. Sullenger, of Fresno, California. The claims are located in a northwesterly direction along a mineralized zone between a slate and meta-volcanic rock.

Although this property is one of the oldest in the region, as yet no extensive mining has been undertaken. Considerable prospect work has been done which consists of open cuts, several short drifts, and two shallow shafts. The ore is stated to run high in silver.

Agnew Meadows Mining Corporation

The Agnew Meadows Mining Corporation holds a group of twelve claims and one fraction on the east side of Agnew Meadows in the Middle Fork basin. Frank Shaw, of Compton, California, is president. The claims are located along the strike of the meta-rhyolite which encloses veinlets and disseminations of sulfide ore over a width which ranges up to 50 feet.

Activity to date has been directed to prospecting for commercial quantities of ore. This has involved the sinking of a shaft and the driving of a cross-cut tunnel to connect with the shaft. The development work is in connection with a mineralized zone which occurs northeast of Agnew Meadows on the Lucky Strike claims.

A branch road from the Minaret Mine road has extended into the Meadows but the road work has been cooperative among several claim holders.

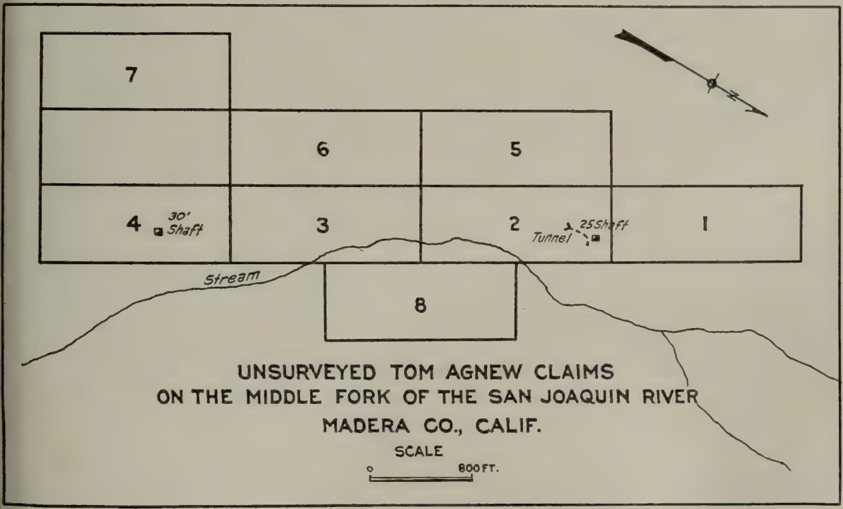
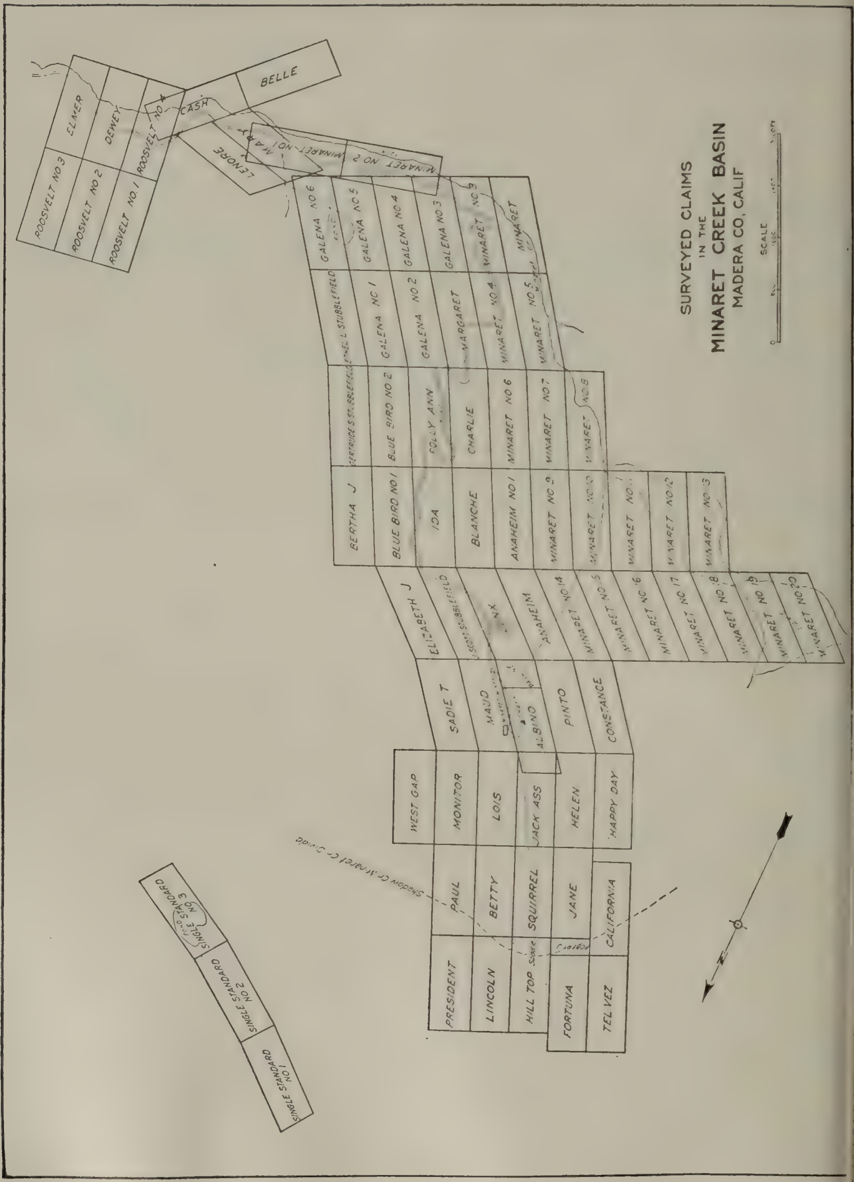

7
6
5
4
30'
Shaft
3
2
25 Shaft
Tunnel
1
Stream
8
UNSURVEYED TOM AGNEW CLAIMS
ON THE MIDDLE FORK OF THE SAN JOAQUIN RIVER
MADERA CO., CALIF.
SCALE
0
800 FT.

FIG. 40

Heriford and Butler Group

Adjoining the Agnew Meadows Group to the south are four claims held by C. Heriford and B. Butler of Laws, California. These locations involve the same conditions as the foregoing group. No development work except that of cooperation in road building has been done.


SURVEYED CLAIMS
IN THE
MINARET CREEK BASIN
MADERA CO, CALIF
SCALE
ELMER
DEWEY
ROOSVELT NO 3
ROOSVELT NO 2
ROOSVELT NO 1
CASH
BELLE
LENORE
MARY
MINARET NO 1
MINARET NO 2
GALENA NO 6
GALENA NO 5
GALENA NO 4
GALENA NO 3
MINARET NO 3
MINARET
STUBBLEFIELD
GALENA NO 1
GALENA NO 2
MARGARET
MINARET NO 4
MINARET NO 5
GERTRUDE S STUBBLEFIELD
BLUE BIRD NO 2
POLLY ANN
CHARLIE
MINARET NO 6
MINARET NO 7
MINARET NO 8
BERTHA J
BLUE BIRD NO 1
IDA
BLANCHE
ANAHEIM NO 1
MINARET NO 9
MINARET NO 10
MINARET NO 11
MINARET NO 12
MINARET NO 13
ELIZABETH J
J SCOTT STUBBLEFIELD
ANAHEIM
MINARET NO 14
MINARET NO 15
MINARET NO 16
MINARET NO 17
MINARET NO 18
MINARET NO 19
MINARET NO 20
SADIE T
MAUD
ALBINO
PINTO
CONSTANCE
WEST GAP
MONITOR
LOIS
JACK ASS
HELEN
HAPPY DAY
PAUL
BETTY
SQUIRREL
JANE
CALIFORNIA
PRESIDENT
LINCOLN
HILL TOP
FORTUNA
TEL VEZ
Shadow Cr.-Minaret Cr. Divide
SINGLE STANDARD NO 3
SINGLE STANDARD NO 2
SINGLE STANDARD NO 1
N

Minaret Mining Company

The Minaret Mining Company holds a group of ten claims which extend from the Minaret Summit down the west slope of the Middle Fork Canyon to Agnew Meadows and a second group of three claims located along a ridge west of the lower Agnew Meadows. Mr. Starkweather of Los Angeles, California, is president. The summit group is located along the strike of meta-rhyolitic rock which is host to sulfide mineralization in veinlets and disseminations over a width which is generally less than a hundred feet. The development work includes the building of a road over which part of the Minaret Mines road was later located, the sinking of a 60-foot shaft equipped with a boom hoist and the opening of many surface cuts in the search for ore outcrops as a thick blanket of pumice overlies most of the surface in this vicinity.

The Agnew Meadows group are located in a quartz sericite schist containing quartz veinlets with sulfides covering a width up to 35 feet. Several opencuts have been made and at one place eight feet of ore is stated to run 20 oz. to 30 oz. of silver in galena.

King Creek Group

Joe Kennedy and Lloyd Summers hold two claims at the lower end of Lake Superior on the upper north fork of King Creek. The deposits constitute a showing of copper ore as chalcopyrite with pyrite. A trail has been built up to the property.

Beasore Group

Several claims are located along the strike of tungsten-bearing veins in the upper Iron Creek basin at about 10,700 feet elevation. These were formerly held by Tom Beasore of North Fork, California, but have since been leased to the Minaret Consolidated Mines Company. A short drift has been driven on the vein.

Burris Group

F. P. Burris of Fresno, California, has three claims in the upper basin of the North Fork River, at about 9300 feet elevation which are known as the Silver King Claims. These lie parallel to each other along quartz veins and veinlets which carry silver-bearing lead-zinc ore. Several open cuts have been made for prospecting purposes and a trail has been built into the canyon.

Bliss Group

H. M. Bliss of North Fork, California, has a group of seven claims adjoining the Burris Group to the northeast at an elevation of about 9700 feet and are known as the Galena King Claims. The development work on this property includes the building of a trail up the canyon wall from the river, the sinking of a 35-foot shaft and the opening of numerous surface cuts and pits. The ore occurs principally in an east-west vein which ranges up to six feet in width and runs largely in lead. In one place, on an average, the ore contained $8.57 in gold, 10.1 oz. in silver and 38% copper across a 6-foot vein width. Individual specimens are stated to run as high as 80% lead and 114 oz. in silver a ton.

Dream Lake Group

This group covers an occurrence of molybdenite at 9300 feet on the east of Red Top Mountain between Minaret and King Creeks. The property was formerly held by S. M. Mingus of Coalinga, California, which included two claims. No development has been made excepting the excavation of a few shallow pits.

Other Properties

It is recognized that other properties have been located in this area which have not received attention herein. These have either not come to the attention of the writer, or represent apparently unimportant showings of ore which have not been consistently located and worked. Such scattered showings of mineral are found in the Thousand Island Lake and Garnet Lake basins, in the upper Middle Fork Canyon, and in the Shadow, Minaret, and King Creek basins.

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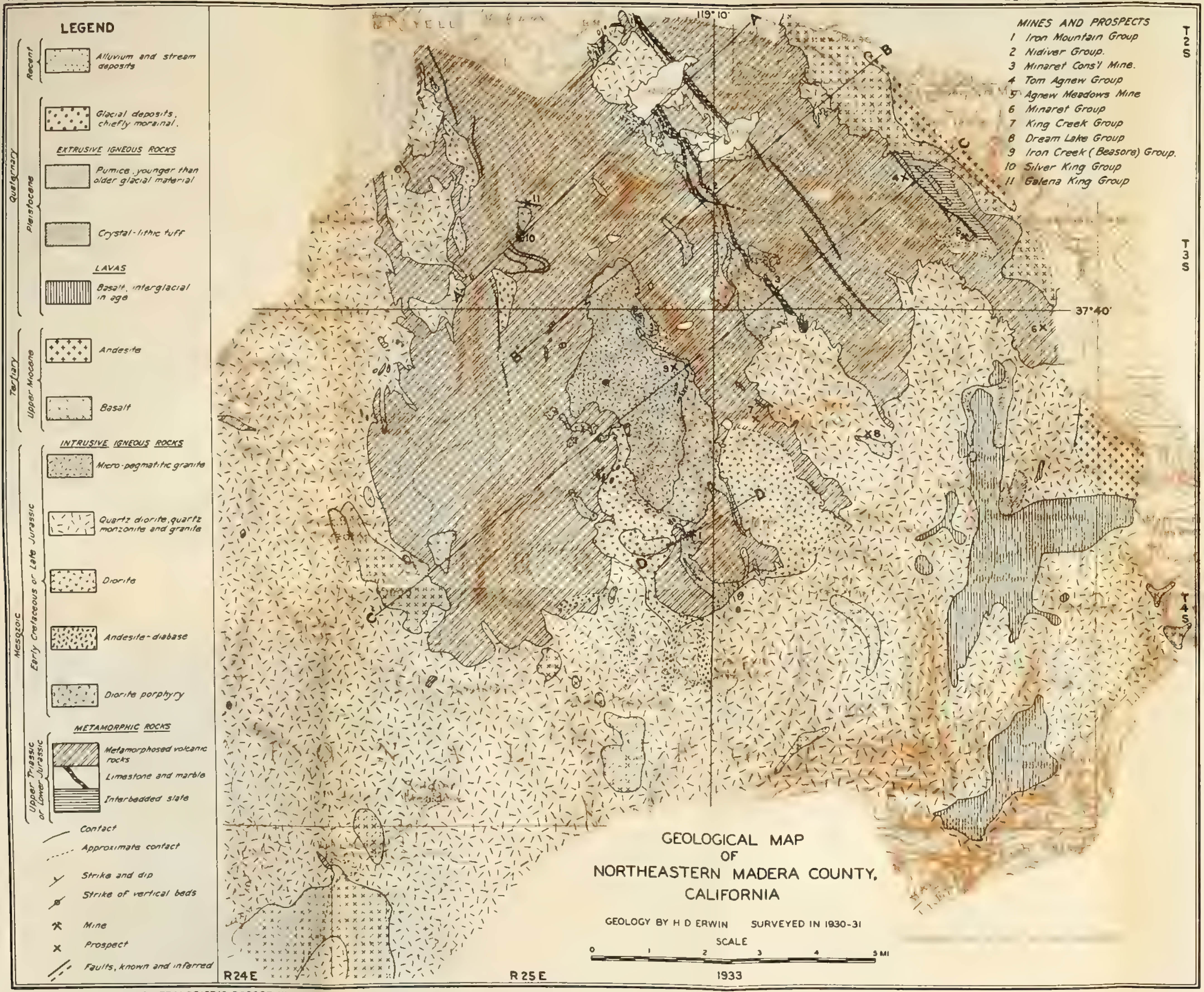
PLATE I

GEOLOGIC BRANCH
OLAF P. JENKINS CHIEF GEOLOGIST

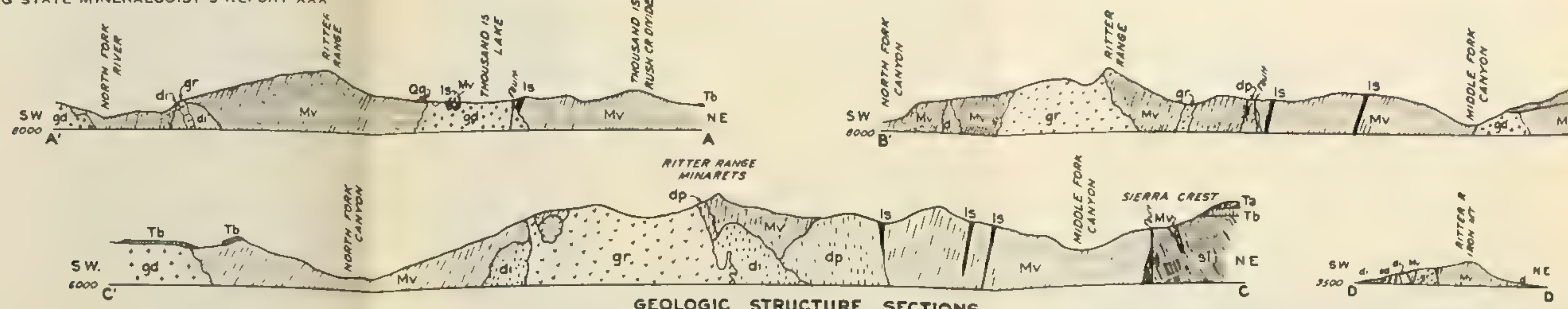

LEGEND
Quaternary
Recent
Alluvium and stream deposits
Pleistocene
Glacial deposits, chiefly morainal.
EXTRUSIVE IGNEOUS ROCKS
Pumice, younger than older glacial material
Crystal-lithic tuff
LAVAS
Basalt, interglacial in age
Tertiary
Upper Miocene
Andesite
Basalt
Mesozoic
Early Cretaceous or Late Jurassic
INTRUSIVE IGNEOUS ROCKS
Micro-pegmatitic granite
Quartz diorite, quartz monzonite and granite
Diorite
Andesite-diabase
Diorite porphyry
Upper Triassic or Lower Jurassic
METAMORPHIC ROCKS
Metamorphosed volcanic rocks
Limestone and marble
Interbedded slate
Contact
Approximate contact
Strike and dip
Strike of vertical beds
Mine
Prospect
Faults, known and inferred
MINES AND PROSPECTS
1 Iron Mountain Group
2 Nidiver Group.
3 Minaret Cons'l Mine.
4 Tom Agnew Group
5 Agnew Meadows Mine
6 Minaret Group
7 King Creek Group
8 Dream Lake Group
9 Iron Creek (Beasore) Group.
10 Silver King Group
11 Galena King Group
119° 10'
37° 40'
T 2 S
T 3 S
T 4 S
R24E
R25E
A
A'
B
B'
C
C'
D
D'
SCALE
0 1 2 3 4 5 MI

GEOLOGICAL MAP OF NORTHEASTERN MADERA COUNTY, CALIFORNIA

GEOLOGY BY H. D. ERWIN SURVEYED IN 1930-31

1933

ACCOMPANYING STATE MINERALOGIST'S REPORT XXX


NORTH FORK RIVER
RITTER RANGE
THOUSAND IS LAKE
THOUSAND IS RUSH CR DIVIDE
SW
8000
A'
gd
di
gr
Mv
Qg
ls
NE
A
Tb
NORTH FORK CANYON
RITTER RANGE
MIDDLE FORK CANYON
SW
8000
B'
gr
dp
ls
Mv
gd
Ta
Tb
NE
B
RITTER RANGE MINARETS
NORTH FORK CANYON
MIDDLE FORK CANYON
SIERRA CREST
SW.
6000
C'
Tb
gd
Mv
di
gr
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RITTER R IRON MT
SW
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D'
NE
D

GEOLOGIC STRUCTURE SECTIONS

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GEOLOGY AND MINERAL DEPOSITS OF LAUREL AND CONVICT BASINS, SOUTHWESTERN MONO COUNTY, CALIFORNIA

By EVANS B. MAYO*

OUTLINE OF REPORT

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INTRODUCTION

The following notes, concerning the economic geology of southwestern Mono County, California, were collected during the course of geologic investigations in that region, mainly under the auspices of the Geologic Branch of the California State Division of Mines. At the request of Olaf P. Jenkins, Chief Geologist, the writer submits these notes, in advance of a more detailed geologic report on the region. Only a few of the more important mining claims will be considered, but it is hoped that the properties chosen will serve to give an idea of the types of mineral deposits encountered in the area.

Some space is given to a discussion of nonmetallic products, and a brief treatment of the most important problem of water-supply is necessarily appended.

The area studied lies on the steep eastern slope of the Sierra Nevada, about 30 miles northwest of the town of Bishop, and extends eastward for a few miles beyond the base of the range. Most of it is embraced in a great re-entrant, conveniently termed the Mammoth Embayment, in which are located the headwaters of Owens River. The extreme northwestern part of the area lies in the Mono Basin, and along the headwaters of Rush Creek, southeast of Mt. Lyell. It includes parts of the Mt. Lyell, Mt. Morrison and Mt. Goddard quadrangles.

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* Temporary field geologist, Geologic Branch, California State Division of Mines.

It is a pleasure to acknowledge the kind assistance of several persons who supplied the writer with information for this paper. Thanks are especially extended to Mr. W. E. Selbie, of Glendale, California, for maps, photographs, and other pertinent material concerning the mineral deposits of Laurel and Convict Canyons, and for the analysis of hot spring water from Casa Diablo. Mr. A. G. Mahan, of Santa Monica, California, generously furnished information regarding the properties of the Mammoth Consolidated Mines Company, of which he is director. In addition, many persons residing in the area have been of assistance on various occasions.

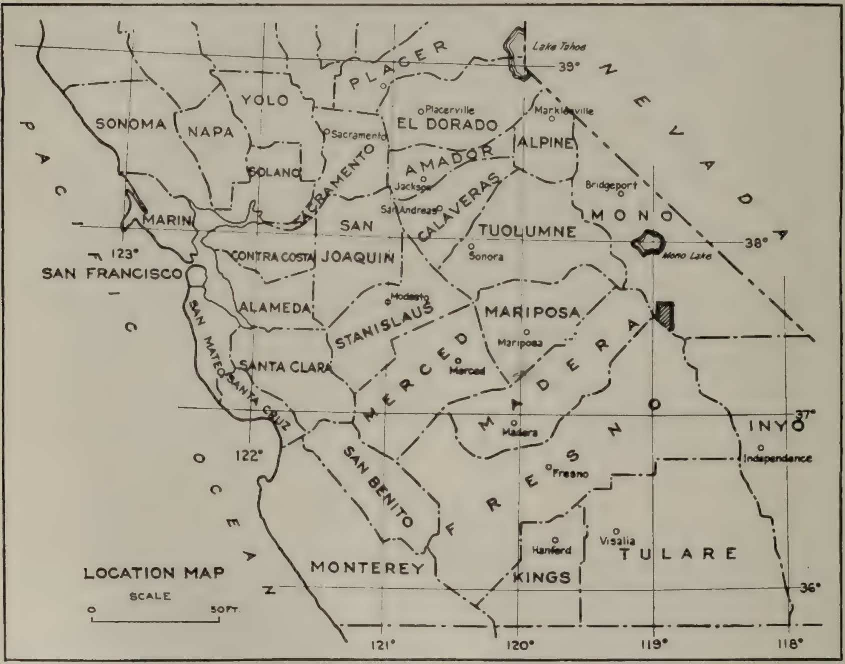

PLACER
Lake Tahoe
39°
NEVADA
YOLO
SONOMA
NAPA
Placerville
EL DORADO
Markleeville
ALPINE
Sacramento
SACRAMENTO
AMADOR
SOLANO
Jackson
Bridgeport
San Andreas
CALAVERAS
MARIN
SAN JOAQUIN
TUOLUMNE
MONO
Mono Lake
38°
123°
SAN FRANCISCO
CONTRA COSTA
Sonora
Modesto
ALAMEDA
STANISLAUS
MARIPOSA
Mariposa
SAN MATEO
SANTA CLARA
MERCED
Merced
MADERA
Madera
SANTA CRUZ
INYO
37°
Independence
122°
SAN BENITO
FRESNO
Fresno
Hanford
Visalia
TULARE
KINGS
MONTEREY
PACIFIC OCEAN
LOCATION MAP
SCALE
0
50FT.
36°
121°
120°
119°
118°

FIG. 1. Index map showing location of area discussed.

GENERAL GEOLOGY

The chief geomorphic feature of the region is the lofty, east-facing scarp of the Sierra Nevada, which in this area attains elevations ranging from more than 9,000 feet, to over 13,000 feet above sea level. This scarp is thought to be a consequence of block-faulting and erosion along the eastern margin of the range. It overlooks a complex, apparently block-faulted expanse of mountain ranges, plateaus, and basins, lying farther east at elevations that vary from 6,000 to 11,000 feet. The older rocks of the area, Paleozoic to Upper Jurassic in age, are exposed in the Sierran scarp, and in nearby mountain ranges and plateaus, while the younger ones, of Tertiary and Quaternary age, occupy the valley floors, cap plateaus, or lie on ancient erosion surfaces in the high mountains.

Pre-Jurassic 'Wall Rocks'

So far as known, these formations carry all of the valuable mineral deposits found in the area.

Meta-sediments.—Under this heading is included a thick series consisting of marble, quartzite, slate, and hornfels, all of which are apparently of marine origin. One of the marble members contains marine fossils of Devonian age. Several periods in the Paleozoic era are probably represented in this group of rocks. Stratification and other sedimentary structures are frequently well preserved. The formations usually dip almost vertically, and strike about N. 35° W. The series occurs as an irregular zone, 0 to 5 miles in width, between two series of granitic intrusions along the Sierran front. The best known area of these rocks, and the most important one from the standpoint of potential economic possibilities, is situated in the Laurel, Convict, and McGee Canyons, southeast of Mammoth.

Meta-volcanics.—These are schistose, or occasionally massive rocks, including metamorphosed acidic and basic lavas, with accompanying meta-tuffs. By analogy with similar formations, of known Triassic age along the western face of the Inyo Mountains, and on the Sierran scarp in Inyo County, these meta-volcanics of Mono County are thought to be also Triassic in age. In many places these rocks are separated from the meta-sediments by a narrow granitic intrusion, which was emplaced along the contact between the two series. The meta-volcanic rocks are isoclinally folded, and, like the meta-sediments, generally strike about N. 35° W., although there are local exceptions. The most important exposures are in upper Mammoth Valley, where the properties of the Mammoth Consolidated Mines Company are located.

Granitic Intrusions

These have doubtless been the ore-bringers, from which the mineralizing solutions were driven, to penetrate the wall-rock. For this reason, in addition to their scientific interest, the granitic rocks are worthy of much detailed study. The intrusions of this area are part of the huge Sierra Nevada composite batholith, which appears to consist of several intrusive groups, with partitions of the metamorphic series between them. In southwestern Mono County, the meta-sediments and meta-volcanic rocks form a septum between a huge compound intrusion, lying mainly to the west of the summit of the range, and an eastern granitic mass occupying the scarp-like front, and forming some of the lesser mountain ranges beyond. As mentioned before, a small intrusion has invaded the metamorphosed septum along the contact between the sedimentary and volcanic series. This small mass is of importance because it is responsible for most of the mineralization discussed in this report.

Younger Volcanic Rocks

Volcanic eruptions doubtless accompanied, as well as followed, the uplift of the Sierra as a lofty fault-block range, in Upper Tertiary and Lower Pleistocene time, long after the almost complete destruction, by erosion, of the mountains formed in consequence of Upper Jurassic folding and plutonic intrusion.[1] It is probable that the positions of the vents were determined by lines of weakness, and that these were the zones of movement along which the fault-blocks were displaced. Copious flows of lava and volcanic mud have issued from time to time along the Sierran front, as well as along the margins of some of the lesser fault-blocks farther east. Some of the older flows (probably of Upper Tertiary age) occupy ancient erosion surfaces on the summit and western slope of the Sierra, or cap plateaus and back slopes of fault-block mountains farther east. The more recent lava fields, however, occupy the valley bottoms, down which the molten material once flowed from fissures located along or near the base of the mountains.

---

[1] Matthes, F. E., Geologic History of the Yosemite Valley: U. S. Geol. Survey Prof. Paper 160, pg. 23, 1930.

Pleistocene and Recent Sediments

Such geologically young deposits are confined almost exclusively to the valley bottom, where they have accumulated as a result of erosion consequent upon the last uplift of the Sierra region. They include glacial moraines, lacustrine deposits (in Long Valley and the Mono Basin), stream sands and gravels, torrent and mud-flow materials, and accumulations of volcanic dust and pumice.

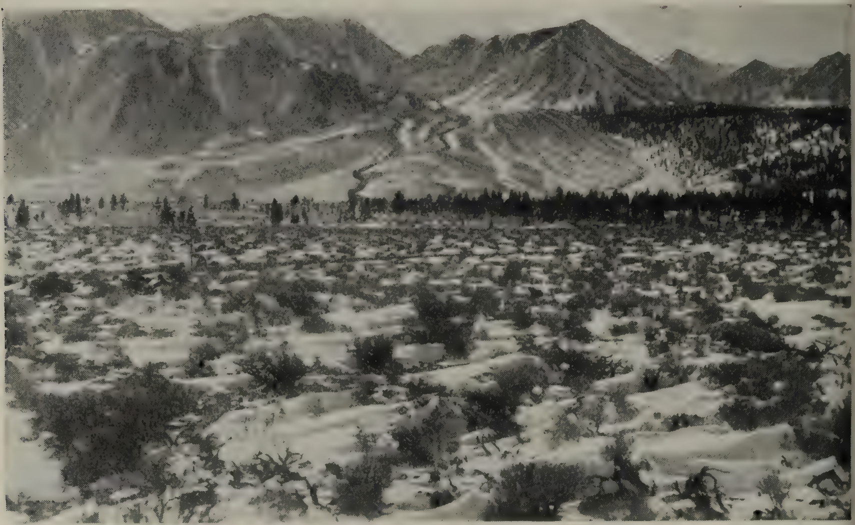
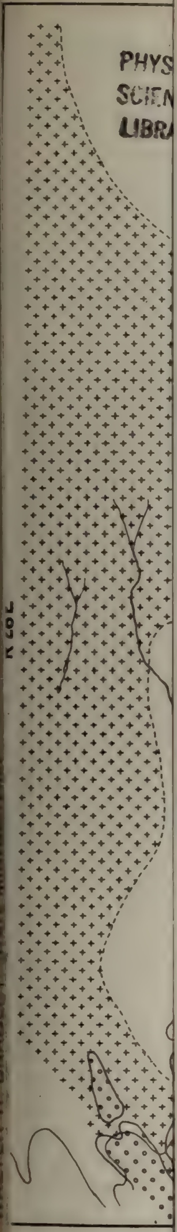


FIG. 2. The Sierra Nevada escarpment about 4 miles southeast of Mammoth Lakes Post Office. The two great furrows in the mountain front are the canyons of Laurel and Sherwin Creeks, from which project high, massive moraines, built up by the Pleistocene glaciers.

Photo taken June, 1931, by W. E. Selbie.

ECONOMIC GEOLOGY

The area has a number of economic resources, some of which, such as forests, grazing land, fish, game, and scenic attractions, are somewhat indirectly related to geologic conditions, and will not be discussed in this paper, although they have been, and some of them still are, of the greatest local importance. Other economic features will be discussed in the following order: mineral deposits, economic uses of the younger volcanic rocks, economic uses of the younger sediments, hydro-electric power, thermal springs, and water-supply.



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form the calcium tungstate or scheelite. Molybdenite has also been introduced, along with pyrite, arsenopyrite, and chalcopyrite. Assays of rock containing these sulfides show gold values as great as $30 per the vents were determined by lines of weakness, and that these were the zones of movement along which the fault-blocks were displaced. Copious flows of lava and volcanic mud have issued from time to time along the Sierran front, as well as along the margins of some of the lesser fault-blocks farther east. Some of the older flows (probably of Upper Tertiary age) occupy ancient erosion surfaces on the summit and western slope of the Sierra, or cap plateaus and back slopes of fault-block mountains farther east. The more recent lava fields, however, occupy the valley bottoms, down which the molten material once flowed from fissures located along or near the base of the mountains.

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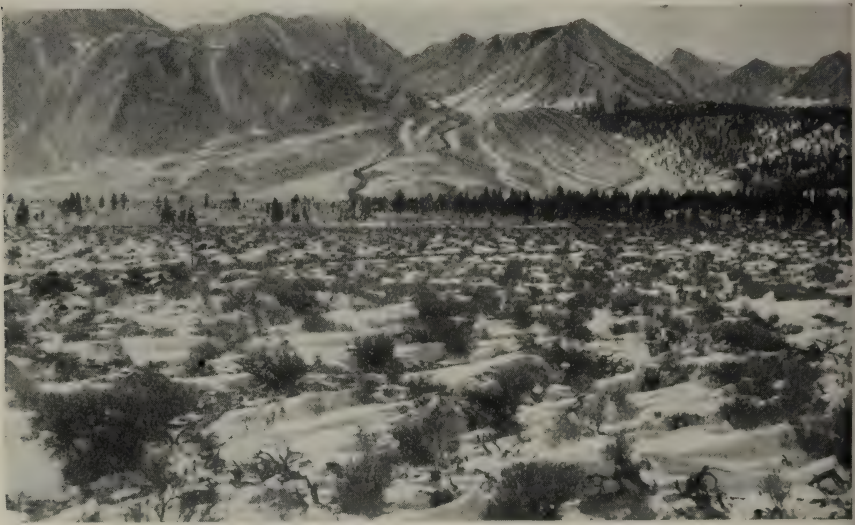

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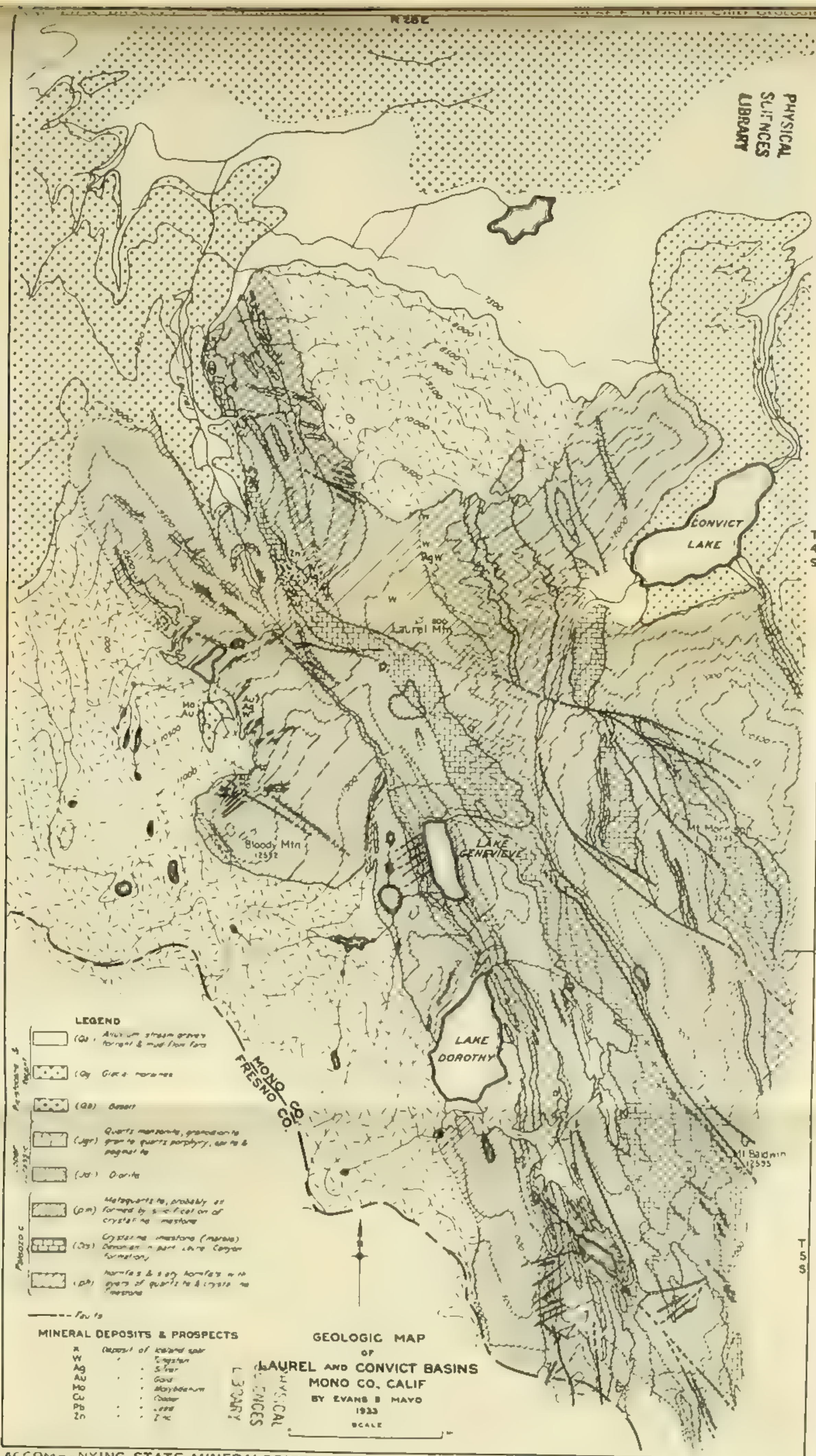
R 28 E
Convict Lake
T 4 S
T 5 S
Laurel Mtn
Bloody Mtn
12552
Lake Genevieve
Lake Dorothy
Mt Morr
Mt Baldwin
12595
Mono Co
Fresno Co
Ag W
W
Mo
Au
Au
Ag
Zn
7500
8000
8500
9000
9500
10000
10500
11000
LEGEND
(Qa) Alluvium stream gravels torrent & mud flow fans
(Qg) Glacial moraines
(Qb) Basalt
(Jgr) Quartz monzonite, granodiorite granite quartz porphyry, aplite & pegmatite
(Jd) Diorite
(pm) Metaquartzite, probably as formed by silicification of crystalline limestone
(Cls) Crystalline limestone (marble) Devonian in part, Laurel Canyon formation
(ph) hornfels & slaty hornfels with layers of quartzite & crystalline limestone
Pleistocene & Recent
Jurassic
Paleozoic
Faults
MINERAL DEPOSITS & PROSPECTS
x Deposit of Iceland spar
W Tungsten
Ag Silver
Au Gold
Mo Molybdenum
Cu Copper
Pb Lead
Zn Zinc
SCALE

GEOLOGIC MAP
OF
LAUREL AND CONVICT BASINS
MONO CO. CALIF
BY EVANS B MAYO
1933

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ACCOMPANYING STATE MINERALOGIST'S REPORT XXX

the vents were determined by lines of weakness, and that tl
zones of movement along which the fault-blocks were displ

greatest local importance. Other economic features will be discussed in the following order: mineral deposits, economic uses of the younger volcanic rocks, economic uses of the younger sediments, hydro-electric power, thermal springs, and water-supply.

Nearly all of the metalliferous deposits are either of the contact metamorphic or hypothermal vein types. A few deposits have features in common with mesothermal types, and in upper Convict Canyon, there are deposits of Iceland spar, thought to be of epithermal origin.

Mineral Deposits in the Meta-Sediments

The best known, and probably most important deposits in the Paleozoic rocks are situated in Laurel and Convict Canyons, southeast of Mammoth. The geology of this small area is shown on the map accompanying this paper. The granite indicated on the southwestern side of the area is a part of the small intrusion, mentioned before as having been emplaced along the contact between the ancient sediments and the meta-volcanic rocks.

The metallic sulfides appear as replacements in crystalline limestone (marble), or in lime-silicate rocks that have been limestones. It should be noted that not only the formations mapped as marble or crystalline limestone, but also calcareous lenses and layers in the hornfels, are to be regarded as probable host-rock to ore. In addition, there is abundant evidence that much, if not all, of the quartzite has been formed by silicification and silication of limestones, so that these rocks are not to be overlooked in a search for ore, because the introduction of valuable minerals may have occurred before, or during, the alteration of the original calcareous rock.

Most of the mining claims in Laurel Canyon are owned by W. E. Selbie and Lloyd Summers of Glendale and Bishop, California, the only exceptions being the Tungsten group of claims, Nos. 1, 2, 3, and 4, which are the property of the late Lee Moyle, of Whittier, California. A small mill, intended to treat ore from these four claims was built in 1929, on Laurel Creek, about one-fourth mile below the lakes, on land leased from Selbie. After the first year, operations ceased.

In Convict Canyon, the claims are owned by the S. S. and K. Mining Company (W. E. Selbie, Lloyd Summers, and Joseph Kennedy).

Contact-metamorphic deposits.—Of this class, the most remarkable one is situated in a cirque on the southern slope of Bloody Mountain, above the Laurel Lakes. The western portion of the mountain rests upon the granite, and is doubtless an unremoved part of the roof of the intrusion. The roof-rock is hornfels, with numerous calcareous layers and lenses, largely altered to lime-silicates, most prominent of which are diopside and grossularite. The structure of the roof-remnant is a recumbent fold, formed by doming of the cover of the rising intrusion. Besides being domed, the roof-rock has been intensely brecciated and fractured, thus making it especially permeable to ore-bearing solutions. The resulting orebodies are doubtless irregular in shape, but mineralization may be concentrated to some extent along certain of the numerous fissures in the roof.

Besides combining with silica, the calcium of the lime-bearing layers has united with tungsten, present in emanations from the granite, to form the calcium tungstate or scheelite. Molybdenite has also been introduced, along with pyrite, arsenopyrite, and chalcopyrite. Assays of rock containing these sulfides show gold values as great as $30 per ton. Since no free gold has been found at this place, it is thought that the metal occurs in combination, or possibly in solid solution, with the sulfides.

The mineralization extends eastward for some distance into the wall rock, but there is some change in the assemblage toward the east; molybdenite disappears, and assays show silver, which is not found in the roof-rock. Similar contact deposits, lacking in molybdenite, have been found on Laurel Mountain by Mr. Selbie. A contact metamorphic deposit, in which scheelite is said to be the principal ore mineral, is situated in crystalline limestone wall-rock on the western side of the valley of Hilton Creek, about one-half mile north of Davis Lake. The deposit is owned by R. W. Phelps and brothers, of Bishop, California.

Veins.—Most of the vein deposits are of Lindgren's hypothermal type, although some of them appear to have characters in common with mesothermal deposits. An excellent example of the hypothermal veins traverses the thick crystalline limestone at the bend in Laurel Canyon, east of the Laurel Lakes. This deposit, which has an exposed length of about 300 yards, and a width of 10 to 20 feet, strikes about N. 30° W., and dips steeply NE. The sulfides present are pyrrhotite, sphalerite, and chalcopyrite, in a gangue consisting chiefly of quartz and tremolite, or actinolite. An assay of the material reports 20.4% zinc, and other assays of material from what appears to be the northern extension of the vein, report 5 ounces of silver per ton. Ore from other veins in the vicinity has yielded much higher silver assays.

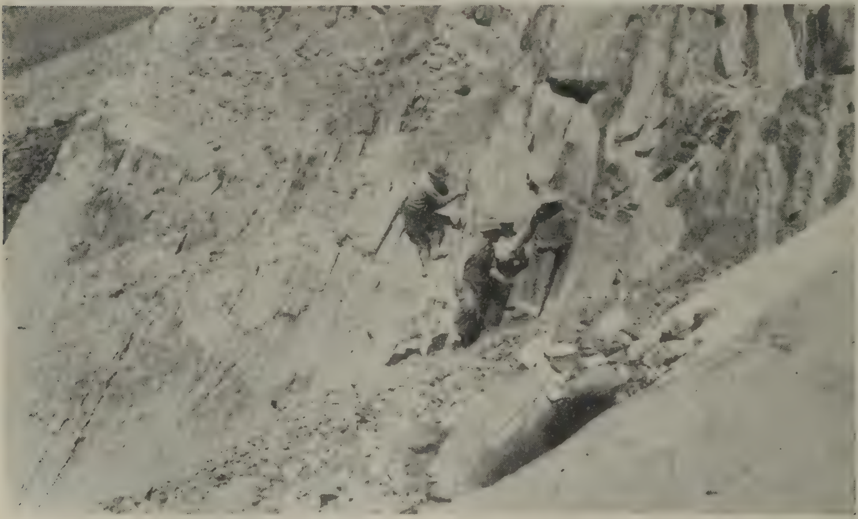

FIG. 3. Miners sampling the "Molybdenum Bluff," on the southern face of Bloody Mountain. The brecciated rock of the cliff overlies the granitic intrusion, which has furnished the ore-bearing solutions.

Photo by W. E. Selbie.

Deposits of Iceland Spar.—Numerous deposits of coarsely crystalline, colorless calcite are situated in the crystalline limestone of the upper Convict basin. At this locality, the prominent marble formation has been most severely deformed. North of the summit of Mt. Baldwin, it has been thrust toward the SE.; south of that peak, on the contrary, it has been strongly thrust NW. Between these two thrusts is a zone of exceedingly complex folding and faulting, in which most of the iceland spar deposits occur.

The bodies of clear calcite are usually lenses, or huge druses, several tens of feet in greatest dimension. The minerals are calcite, in huge crystals (cleavage pieces, reaching one foot in diameter, have been obtained, and serve to give some idea of the size of the complete crystals), and euhedral quartz. A small amount of clay-like matter has been found in some of the druses.

An attempt to determine the quality of the material was made in 1932. Several hundred pounds of the calcite were taken to Pasadena by Robert O. Boykin, a mining engineer, and from one of the pieces a small prism was cut by John A. Anderson, of the Mt. Wilson Observatory. When finished, the prism is said to have been of first-class optical quality.

Mineral Deposits in the Meta-Volcanic Rocks

It is an interesting fact that gold-bearing deposits occur in both meta-sediments and meta-volcanic rocks, on opposite sides of the small intrusion which separates the two series. There is a notable difference in the type of gold deposits in the two series; in the Paleozoic rocks, the highest gold essays have been obtained from contact metamorphic deposits, containing molybdenite and other sulphides, with scheelite; while in the Triassic series, the values are obtained from fissure veins, of hypothermal type, carrying pyrrhotite and arsenopyrite in a gangue consisting mainly of quartz and green silicates that have been identified on various claims as diopside, actinolite, and epidote.

The most important properties are those belonging to the Mammoth Consolidated Mines Company, and situated on the eastern side of upper Mammoth Valley, above and south of Lake Mary.[2] The country rocks are schistose to massive, silicified, basic lava flows and tuffs, with occasional small, dark, metamorphosed intrusions, that may once have been dioritic in composition. Maps which Mr. A. G. Mahan, Jr., kindly permitted the writer to examine, show four principal vein systems, of which the major set (the North and Mother veins) trend almost parallel to the strike of the wall rock, or about N. 20° to 30° W. One important vein (the Footwall) strikes about 15° farther westward. Branching off from these main fissures are a number of shorter ones that trend about 30° farther westward than do the North and Mother veins. In addition, the fourth vein set strikes almost E-W, and appears to cross all of the others. According to Mahan, most of the veins dip about 85° NE, toward the granite, which lies less than one-half mile distant, and has doubtless been the source of the gold-bearing solutions.

Average assays on some of the veins show the values to be about $12 per ton in gold, over a vein width of six feet. The ore is said to be most amenable to flotation concentration, by which process it is expected that a 90% recovery can be made. It is planned to install flotation equipment before operations are resumed on the now idle property. The total expense of mining, concentrating, and transporting the ore is estimated at $4 per ton.

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[2] State Mineralogist's Report XXIII, pp. 380–385, gives something of the history of these properties, and the amount of development at that time (1927). The report states that $200,000 in gold was produced in this district from 1878 to 1881.

Economic Uses of the Younger Volcanic Deposits

No metallization of economic importance has yet been found in the Tertiary and Pleistocene volcanic rocks. These younger formations are not without economic value, however. In the Mono Basin, Pleistocene basaltic lapilli are used for road-metal, with good results. The red lapilli are also used to surface walks at some of the lodges and camps near June and Silver Lakes; borders of the paths are made of small bombs and bomb fragments of the same material. Some of

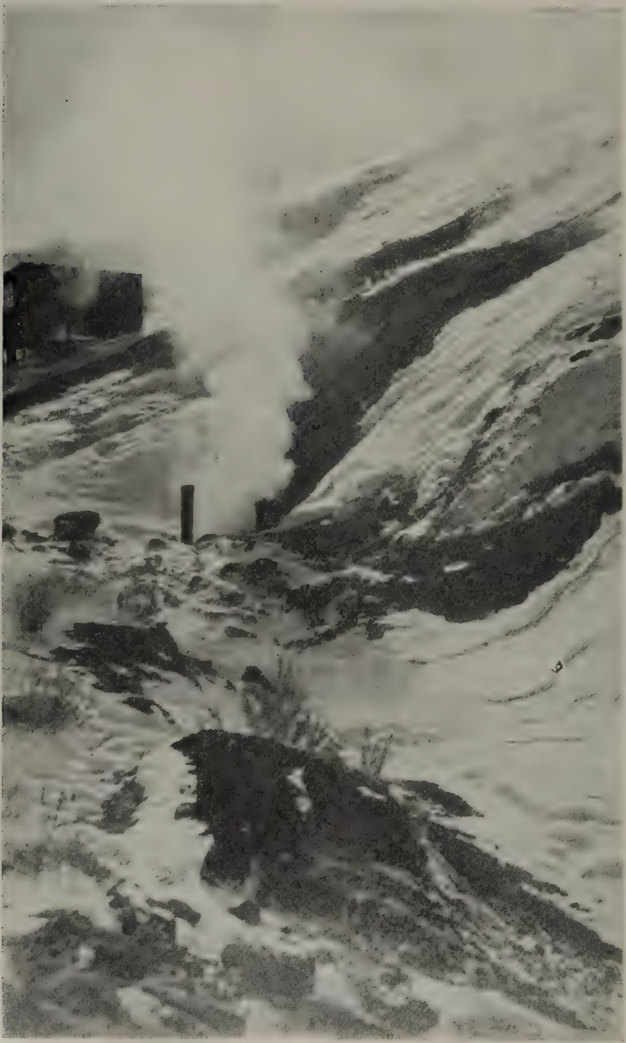
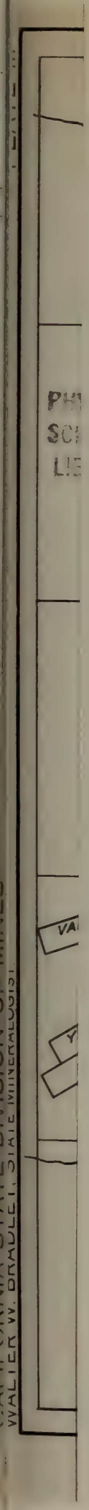


FIG. 4. One of the steam vents at Casa Diablo, in winter.
Photo by W. E. Selbie.


WALTER W. BRADLEY, STATE MINERALOGIST
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property. The total expense of mining, concentrating, and transporting the ore is estimated at $4 per ton.

Economic Uses of the Younger Volcanic Deposits

No metallization of economic importance has yet been found in the Tertiary and Pleistocene volcanic rocks. These younger formations are not without economic value, however. In the Mono Basin, Pleistocene basaltic lapilli are used for road-metal, with good results. The red lapilli are also used to surface walks at some of the lodges and camps near June and Silver Lakes; borders of the paths are made of small bombs and bomb fragments of the same material. Some of

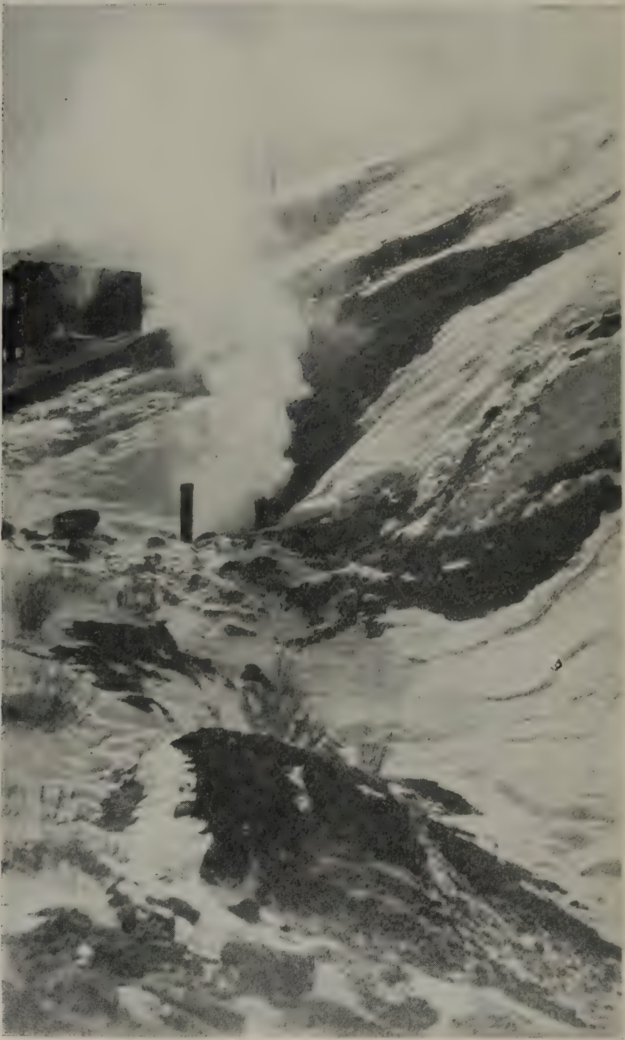

FIG. 4. One of the steam vents at Casa Diablo, in winter.
Photo by W. E. Selbie.

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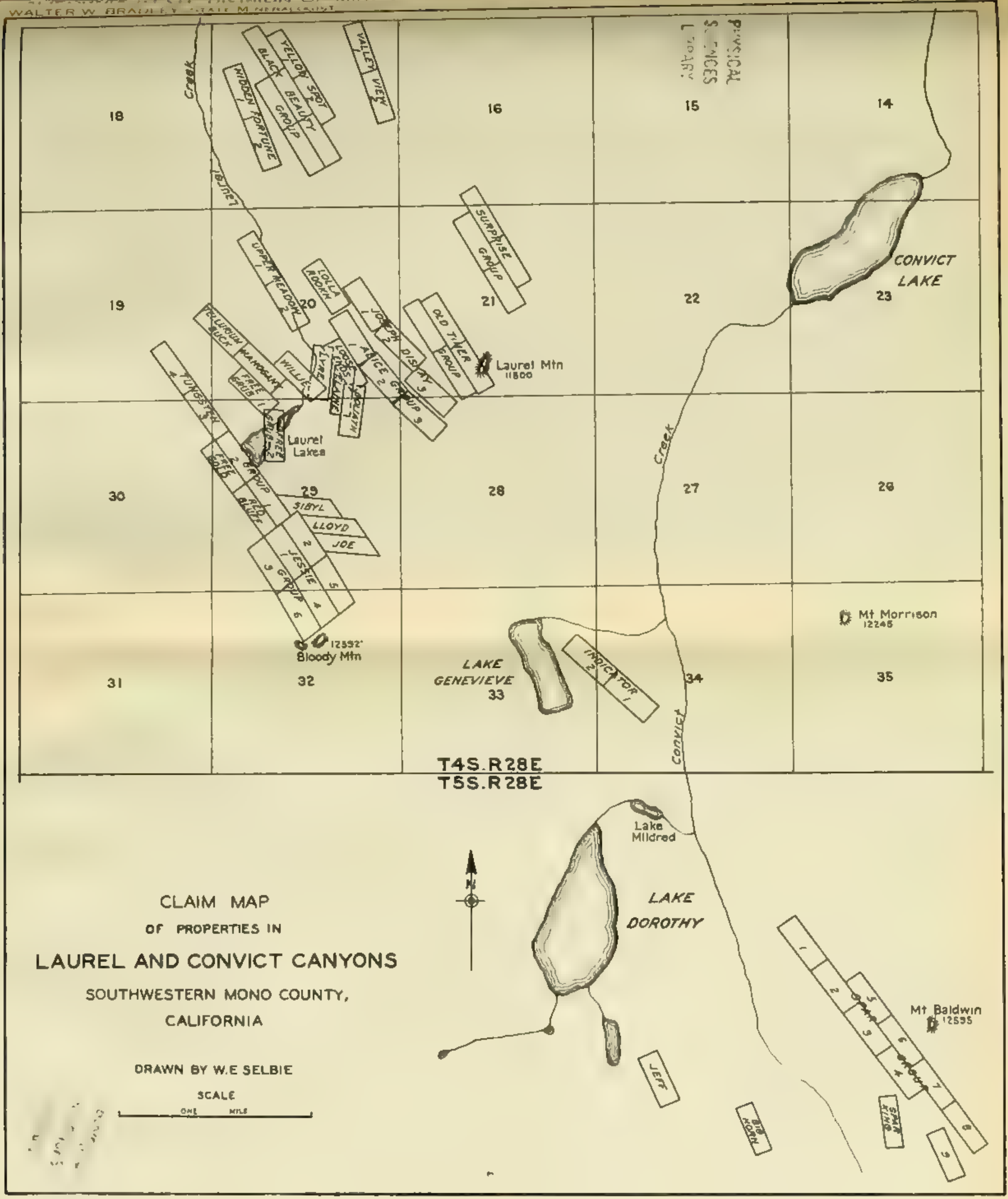
Creek
Laurel
18
WIDDEN FORTUNE 1 2
BLACK BEAUTY GROUP
YELLOW SPOT 1 2
VALLEY VIEW 1 2
16
15
14
SURPRISE GROUP
CONVICT LAKE
19
UPPER MEADOW 1 2
LOLLA ROOKH
20
JOSEPH 1 2
21
22
23
TELLURIUM BUCK
MAHOGANY
FREE GRUB
WILLIE
OLD TIMER GROUP
DISMAY
ALICE GROUP 1 2 3
Laurel Mtn 11800
TUNGSTEN 4 3
FREE GOLD
Laurel Lakes
30
29
28
27
26
Creek
FREE GOLD
GROUP
RED BLUFF
SIBYL
LLOYD
JOE
JESSIE GROUP 1 2 3 4 5 6
Mt Morrison 12245
12592'
Bloody Mtn
LAKE GENEVIEVE
INDICATOR 1 2
31
32
33
34
35
Convict
T4S.R28E
T5S.R28E
Lake Mildred
N
LAKE DOROTHY
JEFF
BIG HORN
STAR KING
STAR GROUP 1 2 3 4 5 6 7 8 9
Mt Baldwin 12555
SCALE
ONE MILE

CLAIM MAP
OF PROPERTIES IN
LAUREL AND CONVICT CANYONS
SOUTHWESTERN MONO COUNTY,
CALIFORNIA

DRAWN BY W.E. SELBIE

ACCOMPANYING REPORT BY E. B. MAYO, IN STATE MINERALOGIST'S REPORT XXX

the Tertiary volcanic mud-flow rocks of the region have found limited use as a building stone. A quarry in this material is located at Round Valley, in northwestern Inyo County. Other materials of possible future value to be obtained from the younger volcanic rocks, include pumice, 'tailor's chalk' (talc), and ornamental stone.

Economic Importance of the Pleistocene Sediments

The most important economic feature of the valley-bottom sediments relates to their serving as reservoirs and conduits for ground-water. Besides this, some of the stream sands and gravels have been used as road-metal. Sand and gravel pits are located in the southwestern corner of Long Valley (by the highway), in lower Mammoth Valley, about one-fourth mile north of the old Summers Ranch (a gravel-filled stream channel, eroded into basalt), and on the western edge of the dry Casa Diablo Lake (wash from the slopes of a rhyolite hill).

Hydro-electric Power

Only a small part of the total amount of water power available in the area is utilized at present. Most of that used is converted into electric energy at stations owned by the Southern Sierras Power Company, and located on Rush and Leevining Creeks. The same company owns other stations along the eastern front of the range, in Inyo County.

Thermal Springs

Numerous fissures in the lavas on the floor of the Mammoth Embayment have, in the past, been sites of intense fumarolic activity, and there are still may places at which hot springs and steam vents exist. Two of these, namely the Whitmore hot spring on the eastern side of Long Valley, and Casa Diablo, in lower Mammoth Valley, about 3½ miles below the village of Mammoth Lakes, are commercialized at present. At the Whitmore Spring, a swimming pool and bathhouse with showers have been built. The springs at Casa Diablo are now merely steam vents, over which small bathhouses have been built.

Analysis of Water from Casa Diablo, Mono County, California

Smith-Emery Company, Los Angeles, Analysts

Analysis of solids	*Grains per U. S. gallon*
Suspended matter	Trace
Silica (SiO_2)	0.05
Iron oxide and alumina (R_2O_3)	Trace
Lime (CaO)	0.25
Magnesia (MgO)	0.09
Soda (Na_2O)	0.14
Sulphuric anhydride (SO_3)	None
Chlorine (Cl)	0.17
Carbon dioxide, combined (CO_2)	0.30
Total	1.00
Excess oxygen	0.05
Total solids	0.97
Hypothetical combination—	
Suspended matter	Trace
Silica	0.05
Iron oxide and alumina	Trace
Calcium carbonate	0.45
Calcium sulphate	None
Calcium chloride	None
Magnesium carbonate	0.19
Magnesium chloride	None
Sodium carbonate	None
Sodium sulphate	None
Sodium chloride	0.28
Total solids	0.97
Determinations—	
Carbon dioxide (CO_2), half bound	0.30
Carbon dioxide (CO_2), uncombined	1.46
Hydrogen sulphide (H_2S)	0.06
Dissolved oxygen (O_2)	n.d.
Hydrogen ion concentration (pH)	4.4
Organic matter	0.07

Water-Supply

With the growth of large cities on the Pacific Coast, there has risen an increasing demand for water-supply, greater, in the case of some Californian cities, than can be furnished from local sources. In the largest western city, Los Angeles, the solution of the problem has been accomplished by the construction of an aqueduct across deserts and mountain ranges to carry water derived from melting snow on the eastern flank of the Sierra, in Inyo and Mono counties, to the metropolis. An excellent account of this undertaking, and of the problems that have been created by the taking of water from agricultural communities in Owens Valley, has recently been published by W. A. Chalfant, of Bishop.[3]

Since Mono County is located, in part, on the headwaters of Owens River, the water resources of the southwestern part of the county are most important. Even those portions of this area which lie in the undrained Mono Basin may eventually furnish water to the city, because surveys have already been made for the construction of a tunnel and the necessary canals to divert water from creeks of Mono Valley, and conduct it through the southern rim of the basin, into Long Valley. In addition, a dam, to be constructed at the outlet of Long Valley, will create a reservoir of capacity sufficient to insure an adequate flow of water through the aqueduct at all times.

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[3] Chalfant, W. A., The Story of Inyo, 2d Edition, pp. 337–411, 1933.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From October 1, 1933, to and including December 30, 1933, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
Kettleman North Dome Assoc.	20	21 S.	17 E.	4	Kettleman North Dome
Kettleman North Dome Assoc.	20	21 S.	17 E.	36	Kettleman North Dome
Kettleman North Dome Assoc.	20	21 S.	17 E.	67	Kettleman North Dome
Kettleman North Dome Assoc.	28	21 S.	17 E.	54	Kettleman North Dome
Kettleman North Dome Assoc.	30	21 S.	17 E.	61	Kettleman North Dome
Kettleman North Dome Assoc.	32	21 S.	17 E.	74	Kettleman North Dome
Standard Oil Co.	19	21 S.	17 E.	74	Kettleman North Dome
Standard Oil Co.	27	21 S.	17 E.	4	Kettleman North Dome
Superior Oil Co.	29	21 S.	17 E.	Huffman 7	Kettleman North Dome
Union Oil Co.	29	21 S.	17 E.	King 5	Kettleman North Dome
HUMBOLDT COUNTY:					
Willard W. Dinwiddie	17	4 N.	1 W.	Buhne 1	
IMPERIAL COUNTY:					
E. J. Piatt	24	10 S.	13 E.	1	
Clem T. Reese	12	11 S.	13 E.	Clem Reese 1	
KERN COUNTY:					
Belridge Oil Co.	27	27 S.	20 E.	30–27	Belridge
Union Oil Co.	36	27 S.	20 E.	Belridge 18	Belridge
Milham Exploration Co.	6	28 S.	23 E.	Lincoln Petroleum Corp. Page 1	Buttonwillow Gas
Milham Exploration Co.	8	28 S.	23 E.	12–8	Buttonwillow Gas
Tarr & McComb Oil Co., Ltd.	23	29 S.	27 E.	Green 1	Fruitvale
Western Gulf Oil Co.	22	29 S.	27 E.	13-KCL-B	Fruitvale
Bankline Oil Co.	28	28 S.	27 E.	Robinson 1	Kern River
Shell Oil Co.	21	29 S.	21 E.	Midway-Premier 1	McKittrick
General Petroleum Corp.	16	27 S.	28 E.	Heisen 9	Mt. Poso
General Petroleum Corp.	16	27 S.	28 E.	Heisen 26	Mt. Poso
General Petroleum Corp.	16	27 S.	28 E.	Heisen 46	Mt. Poso
C. R. Hannaman & Associates	21	27 S.	28 E.	1	Mt. Poso
John Lewis	25	27 S.	28 E.	Lewis 1	Mt. Poso
Pacific Western Oil Co.	15	27 S.	28 E.	Glide-Vedder 8	Mt. Poso
Pacific Western Oil Co.	15	27 S.	28 E.	Glide-Vedder 9	Mt. Poso
Pacific Western Oil Co.	15	27 S.	28 E.	Glide-Vedder 10	Mt. Poso
Pacific Western Oil Co.	15	27 S.	28 E.	Glide-Vedder 11	Mt. Poso
Petroleum Development Corp.	8	27 S.	28 E.	Vedder 3	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 9	Mt Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 10	Mt. Poso
Hogan Petroleum Co	29	30 S.	29 E.	Haley 1	Mountain View
Hogan Petroleum Co.	29	30 S.	29 E.	Porter-Day 3	Mountain View
A. T. Jergins Trust	29	30 S.	29 E.	Bloemer 1	Mountain View
A. T. Jergins Trust	29	30 S.	29 E.	Bloemer 2	Mountain View
A. T. Jergins Trust	30	30 S.	29 E.	Nance 1	Mountain View
E. L. Labadie	29	30 S.	29 E.	Cavanaugh 1	Mountain View
Mohawk Petroleum Co.	24	30 S.	28 E.	McKeehan 1	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	C. W. Bloemer 1	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Hood 3	Mountain View
Comanche Oil Co.	15	32 S.	29 E.	Comanche 1	
Monterey Exploration Co.	15	30 S.	29 E.	Duff 3	
Shafter Oil Syn.	8	28 S.	25 E.	1	
KINGS COUNTY:					
Petroleum Securities Co.	19	23 S.	19 E.	58	Kettleman Middle Dome
Carl W. Weller	11	23 S.	16 E.	Baby King 2	
LOS ANGELES COUNTY:					
Standard Oil Co.	13	3 S.	11 W.	Emery 54	Coyote Hills
Shell Oil Co.	33	3 S.	13 W.	Reyes 50	Dominguez
T. T. Nudson	17	2 S.	14 W.	1	Inglewood
Atascadero Oil Co.	20	4 S.	12 W.	Willett 2	Long Beach
R. R. Bush Oil Co.	19	4 S.	12 W.	Hillseth 4	Long Beach
Dabney-Johnston Oil Corp.	20	4 S.	12 W.	90	Long Beach
Nedal Oil Co.	19	4 S.	12 W.	1	Long Beach
Par Petroleum Corp.	20	4 S.	12 W.	3	Long Beach
Petroleum Production Corp.	19	4 S.	12 W.	Mun 1	Long Beach
Richfield Oil Co.	19	4 S.	12 W.	Hoffman 2	Long Beach
Sig-Mar Drilling Co., Inc.	19	4 S.	12 W.	1	Long Beach
V. R. G. Wilbur	19	4 S.	12 W.	Butler 1	Long Beach
Wil-Daw Oil Co.	20	4 S.	12 W.	Wil-Daw 1	Long Beach
The Texas Co.	6	2 S.	11 W.	Barry 4	Montebello
Continental Oil Co.	11	5 S.	12 W.	Bixby 32	Seal Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Continued					
George L. Clayton	31	3 S.	12 W.	1	
Thomas Kelly & Sons, Inc.	7	4 S.	13 W.	Kelly-Del Amo 1	
Midfield Oil Co.	19	2 S.	11 W.	Midfield-Walker	
MONTEREY COUNTY:					
James M. Douglas	36	22 S.	9 E.	Smith 1	
ORANGE COUNTY:					
Bardeen Petroleum Co., Ltd.	13	3 S.	10 W.	C-1	Coyote Hills
Standard Oil Co.	18	3 S.	10 W.	Murphy-Coyote 115	Coyote Hills
Standard Oil Co.	13	3 S.	11 W.	Emery 55	Coyote Hills
Albert Allen	10	6 S.	11 W.	2	Huntington Beach
Thomas W. Bewley	10	6 S.	11 W.	1	Huntington Beach
S. M. Brooks	10	6 S.	11 W.	A. C. Chollett Co. Brooks 1	Huntington Beach
S. M. Brooks	10	6 S.	11 W.	Brooks 2	Huntington Beach
Calawaii Petroleum Corp.	10	6 S.	11 W.	Calawaii 1	Huntington Beach
Centralia Oil Co.	10	6 S.	11 W.	1	Huntington Beach
Centralia Oil Co.	10	6 S.	11 W.	Centralia 2	Huntington Beach
Centralia Oil Co.	10	6 S.	11 W.	Centralia 4	Huntington Beach
Colliton & Dilbeck, Inc.	10	6 S.	11 W.	1	Huntington Beach
Elyod Oil Corp.	10	6 S.	11 W.	3	Huntington Beach
Elyod Oil Corp.	10	6 S.	11 W.	4	Huntington Beach
Gray Eagle Oil Co.	10	6 S.	11 W.	Gray Eagle 1	Huntington Beach
H. B. Oil Co.	10	6 S.	11 W.	H. B. 1	Huntington Beach
A. T. Ingalls	10	6 S.	11 W.	1	Huntington Beach
McVicar-Rood	10	6 S.	11 W.	S. & G. 1	Huntington Beach
Milroy Oil Co., Inc.	10	6 S.	11 W.	1	Huntington Beach
Montana Petroleum Corp.	10	6 S.	11 W.	Montana Treat 2	Huntington Beach
The Petrol Corp.	10	6 S.	11 W.	Lambert 2	Huntington Beach
Reading Oil Corp.	10	6 S.	11 W.	Reading-Anderson 2	Huntington Beach
C. P. Ritter Production Dept.	10	6 S.	11 W.	Signal 2	Huntington Beach
Simaroo Oil Co.	10	6 S.	11 W.	Morris 3	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	Huntington B. 67	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 20	Huntington Beach
Venton Oil Co.	10	6 S.	11 W.	Ames 3	Huntington Beach
Cal-Pan Oil Co.	29	3 S.	9 W.	1	Richfield
Cook & Hesse Oil Co.	28	3 S.	9 W.	Soderberg 2	Richfield
Superior Oil Co.	19	5 S.	11 W.	Alamitos 1	
SAN BERNARDINO COUNTY:					
Tehama Petroleum Corp.	33	2 S.	8 W.	Kraemer-Backs 1	
SAN LUIS OBISPO COUNTY:					
Dollie Adams	31	31 S.	13 E.	4	Arroyo Grande
Willett Oil Co.	10	25 S.	15 E.	Jack 2	
SANTA BARBARA COUNTY:					
Fred Cole	28	4 N.	27 W.	McMillen 1	Mesa
R. & M. Oil Co., Inc.	28	4 N.	27 W.	1	Mesa
Union Oil Co.	26	9 N.	34 W.	Calif. Coast 14	Santa Maria
Julius Dietzmann	16	4 N.	26 W.	1	Summerland
SANTA CLARA COUNTY:					
Madrone Oil Co.	8	9 S.	1 W.	1	
TULARE COUNTY:					
Baker-Grover Co.	10	23 S.	27 E.	Baker-Grover 1	
VENTURA COUNTY:					
Laing & Jacobs	32	4 N.	19 W.	Snodgrass 1	Bardsdale
Garner Royalties Co., Ltd.	12	4 N.	22 W.	1	Ojai
Shell Oil Co.	28	3 N.	23 W.	Gosnell 35	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

NOTES ON SAMPLING AS APPLIED TO GOLD QUARTZ DEPOSITS

By HOMER D. ERWIN *

The proper sampling of a mining property, whether it be a prospect or a developed mine, is obviously fundamental to gaining a thorough understanding of the worthiness of the property. Systematic sampling may be a guide to the development of underground workings of a prospect or mine, or it may be used to determine the ore-reserves by blocked-out workings in a developed mine.

By definition, a mine is an excavation from which mineral can be produced at an economic profit for a certain period of time. It is thus evident that the economic status of a mining property can only be obtained by careful and systematic sampling. The assay of a single sample of ore tells one the values that are carried in the deposit only at the place from which the sample was extracted and obviously does not give information as to the average value of the deposit. Since the determination of the average value of a body of ore is the object of economic consideration, it is evident that this can only be obtained by taking a multiple of samples at systematic intervals. They may be taken across a natural vein outcrop, down a shaft or winze on the dip, across the back of a drift on the strike, or up a raise on the dip. The interval and regularity of the sampling is determined by the distribution of values according to the nature of the deposit as determined by preliminary sampling together with an examination to determine the nature and grade of ore, and the concentration of values as related to the geological features. Too many samples can not be taken but too few fail in the purpose for which the

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* Mining Geologist, Jackson, California.

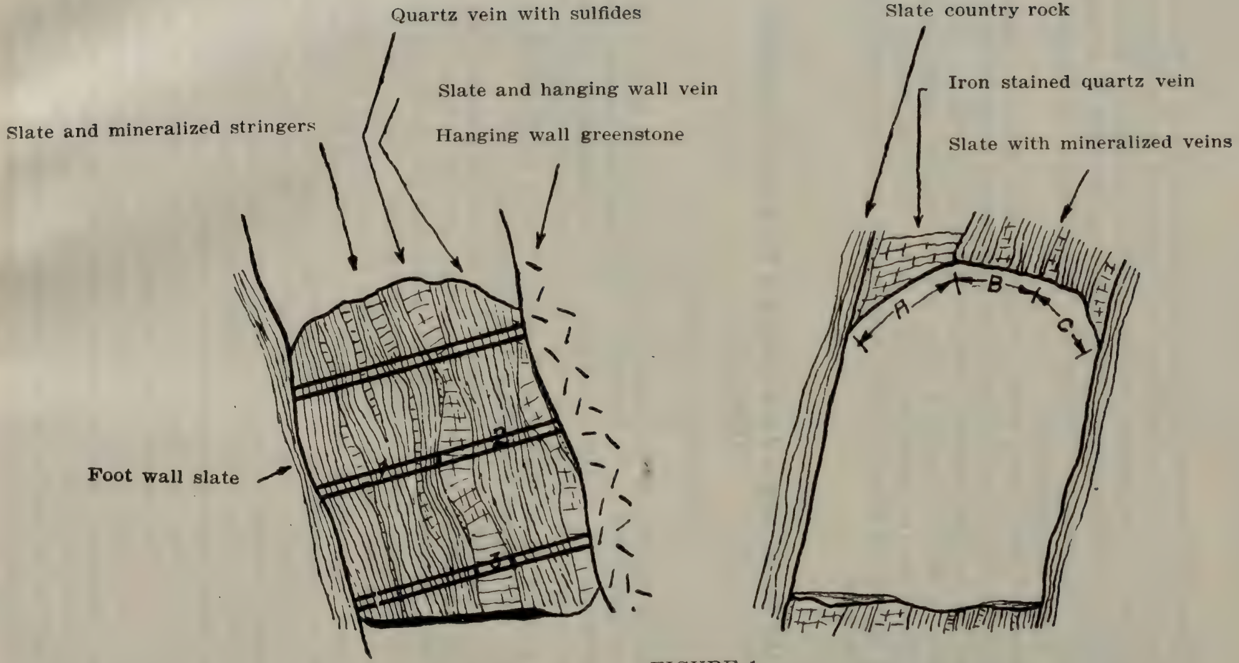
Slate and mineralized stringers
Quartz vein with sulfides
Slate and hanging wall vein
Hanging wall greenstone
Foot wall slate
1
2
3
Slate country rock
Iron stained quartz vein
Slate with mineralized veins
A
B
C

FIGURE 1

A

A drift face showing the position of three cut samples, to be separate, combined to make a composite, and special samples as designated by numbers 1, 2 and 3.

B

A drift cross-section showing the general arch roof. More sample should be taken along B than along A and C because the latter surfaces are not at right angles to the mineralized structures.

samples were taken. It is by far the wisest plan to spend a little money in the beginning for assay results on a larger number of samples which mean something, than to go ahead blindly, and needlessly spend a few hundred or perhaps a few thousand dollars on a mining venture that through sampling would have showed unjustified.

Of equal paramount importance in the economic consideration is the fact that a sample should represent a body of rock that can be practically mined. In underground sampling, therefore, it is important that a sample shall generally represent a body of rock that is at least two and a half feet in width. This is about the minimum width at which a stope can be carried. It follows then, that wall-rock material necessary to make up for a minable width in the extraction of the ore should be included where a vein or mineralized zone under this width limit exists. This fact should be considered in all cases whether or not selective methods and sorting can be practiced.

The methods and practices of sampling have frequently been discussed in technical literature and herein is given only brief and practical notes, of popular demand, and as applied principally to prospects and mines in gold-quartz deposits. In the beginning, it is recommended that readers who are inexperienced in gold mining problems in general, would do well to consult a brief and practical treatise on the subject such as found in Bulletin 363 recently published by the U. S. Bureau of Mines.[1] A more detailed discussion is given by T. J. Hoover.[2] The discussion of the subject of sampling naturally includes methods which are applicable to all types of tabular ore deposits. The well-known erratic distribution of primary gold values makes the sampling of gold deposits necessarily a cautious undertaking. Native gold may occur finely distributed and unseen in rock, or it may occur in visible quantities as free metal or intimately bound up in primary sulfide minerals. Gold-bearing material should, therefore, be sampled and assayed to determine not only the true value but the relative distribution of the gold.

Experience and good judgment are the best qualifications for a sampler, as sampling and methods of procedure vary considerably from one deposit to another. Of the human element, an honest conviction is absolutely essential at all times. It is natural to select the choicest rock in taking samples, but it is admitted that unless they represent a sufficiently extensive workable body of rock, on an average, they have little or no value.

There are numerous methods of sampling which are applicable to gold quartz veins deposits. Among these are: channel, pick, drill, grad, and bulk sampling. The first type is most accurate and best adapted to tabular types of deposits and for this reason is here discussed more fully.

CHANNEL SAMPLING AND PRACTICES

The channel or cut sample consists of cutting a channel of rock of uniform width and depth at right angles to the walls of a vein, stringers or shear zone in strike and dip. An attempt at true uniformity is,

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[1] Jackson, L. F., and Knaebel, J. B., Gold mining and milling in the United States and Canada: U. S. Bureau of Mines Bull. No. 363. Sampling discussed on pp. 44–48.

[2] Hoover, T. J., Economics of mining, 1933.

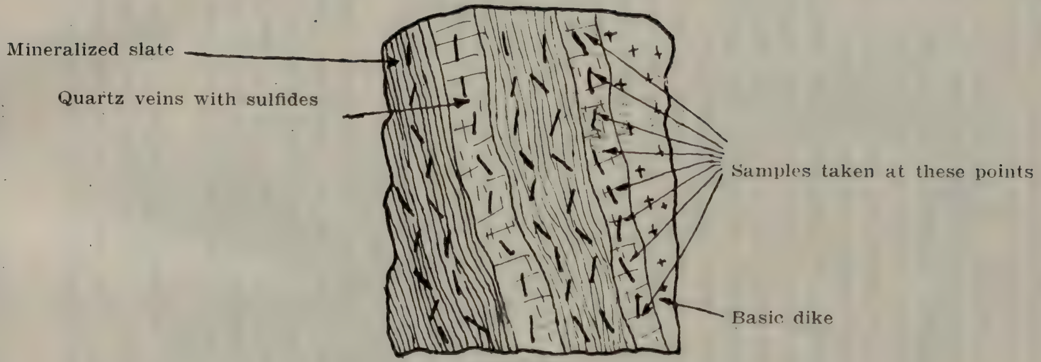
Mineralized slate
Quartz veins with sulfides
Samples taken at these points
Basic dike

FIGURE 2
A drift face showing parallel mineralized structures and positions of pick samples.

of course, desired but practical experience shows that that is difficult to achieve because of irregularities of rock structures. The size of channel cut may vary, but a common practice is to take a cut of material about 4 inches wide and a quarter of an inch in depth which gives about one pound of material per linear foot. The sample may be cut up to a depth of two inches. Generally a wider and deeper cut is taken over a short width and a narrower and shallower cut over a greater distance, but it is important to keep the same standard of cuts in a set of samples representing the same unit of ore. In preparation to taking a sample, the surface to be sampled should be cleaned or washed of any material not representative and foreign to the rock in place, as dirt and soluble salts. Extreme care should be exercised in this respect, for the samples should not be contaminated. It is a good practice to make a shallow cut to smooth and dress the surface of loose or projecting pieces of rock matter, followed by the sample cut taken in the same place. Marking the position of channel cuts with the soot of a carbide lamp in advance of taking a group of samples is practised but this should not be done where it might serve as a sign for salting. In spotting for a cut sample, places where free gold can be seen should be avoided, and the sample taken to one side or the other. A high grade spot should not be purposely included in a sample unless it falls at the regular interval at which the series of samples are being taken, or unless it is arbitrarily desired to know its value. Again, let it be emphasized that the length of a single cut shall be at least a minable width of about two and a half feet or more. The length of the cut is always recorded in inches, numbered and designated as to location and any remarks noted. In hard rock, a moil and single-jack hammer are best for picking down a sample, while in softer rock a pick may be sufficient. Cuts should never be taken entirely along soft spots, seams, stringers or fractured rock and slips as there is a possibility of getting nonrepresentative material such as gold concentrated in a seam, or a rich stringer ''frozen'' to a wall. Commonly, in gold vein deposits, parallel structures are present which offer varying degrees of hardness, and a sampler may be inclined to get more of the softer or easily broken material and less of the harder material. It is admitted that these conditions are sometimes difficult to overcome but a uniform amount of material per linear distance should be obtained as near as possible. In such cases it may be best to take separate cuts of the different bands of material and calculate the total average value from these separate results and at the same time get an accurate check on the localization of values. The average value is obtained by multiplying the assay value of each band by the length, adding the products, and dividing by the sum of all the lengths. The sample is generally caught on a heavy canvas held directly under the cutting tool or as near as convenient so that all the material possible is recovered. A large canvas area is needed for collecting a sample where the cutting makes many flying parts as in moiling hard rock. Under this condition also it may be advisable for the sampler to wear a pair of unbreakable goggles. A smaller canvas area may be all that is needed for cutting soft rock. A wide sample may be caught in a small canvas by cutting as much material as it will hold, this placed in the sample sack, and the sampling resumed where left off and the whole cut made by successive stages. Where cuts are taken at a drift face, the canvas may be laid on the floor and snugly laid up to the face and the material allowed to fall down the face providing the formation is hard and clean so that it does not contaminate the sample. In cutting across the back of a drift, a large canvas may be placed on the floor directly under the cut. In sampling difficult and awkward places as may be found in a shaft, raise or stope, the cutting and proper collecting of the sample may be a two-man operation.

Relative to vein structure, the deposit might consist of a wide, moderate, or narrow quartz vein or mineralized shear zone with values concentrated in one portion or throughout. The mineralization may also consist of a series of mineralized stringers or country rock.

In sampling a vein or mineralized zone that is greater than five feet in width, it is well to consider the internal structures. A cut sample from wall to wall would indicate the average value, while a cut representative of the various structures present should be taken to show the localization of values. It is advisable not to take any single cut sample over five feet in length. After the general occurrences of values have been located, a mining problem may be presented to solve the best procedure for exploitation. Walls controlled by structures within the vein are rarely as good as the country-rock walls for carrying mine workings, and generally a whole vein is either mined or left. In large veins, a country-rock horse or dike may split the vein, and in such a case respective samples would indicate the values and consequent method of attack.

Moderate veins and mineralized zones from five feet down to two and a half feet in width are generally sampled from wall to wall. Narrow veins, from a mining standpoint, are two and a half feet and less in width. In mining the latter, stripping is generally practiced, and although it may be practical to sort mineral material, samples must be taken to represent a full mining width.

In many cases the deposit may include a series of mineralized stringers and veinlets including country rock in which case the only practical method would be to take a cut sample across the total width as near right angle to the structures as possible. Such a sample would generally be taken at a convenient height along the wall of a cross-cut while special samples may be taken to find the localization of values.

In sampling the face of a drift, it is good practice to make a composite sample of three separate cut samples. One sample may be taken at or near the roof, one taken at the middle of the face while a third is taken at the bottom. Figure 1-A shows an example of a drift face with the position of the three cuts for a composite sample. To obtain the localization of values, the cuts would be taken separately as 1, 2, and 3 in the figure. In a developed drift, the samples are best taken across the back of the drift, on the vein or mineralized zone at regular intervals. When sampling the back of a drift, care must be taken that the sample represents as near as possible a cut which is perpendicular to the vein walls for roofs are often arch shaped and would not give true cuts. As shown in Figure 1-B, more sample material should be cut along B to make allowance for the irregularities along A and C. Flat arched roofs may be dressed sufficiently before taking a cut.

A drift floor makes for unsatisfactory sampling because of the undue chances of contamination and salting of the samples. However, this may offer the only place for sampling where overhand stoping has been done. Large samples should be taken and washed free of their fine material. In a shaft, winze, or raise, the samples should be taken at intervals down the dip of the vein or mineralized zone at one side of the working. A face sample at the extremity of any of these workings may be taken similar to that as described in taking a drift face sample. In sampling the bottom of a shaft or winze, it is better to cut the sample on the walls as near the bottom as possible, for cutting samples at the bottom is difficult and more easily contaminated.

Cut samples can also be taken on natural surface outcrops, or where cross-cut trenches have been dug for the purpose of uncovering the vein from overburden material. If trenching is to be done in view of sampling, the trenches should be placed at intervals, preferably at twenty feet to start with and lessened or increased as the conditions justify. Care should be taken that the samples are not contaminated by the overburden material.

The interval at which channel or cut samples should be taken in gold quartz deposits is a matter to be decided for each particular deposit. Due to the erratic occurrence of gold generally, it would be best to sample at intervals as close as possible. The matter, however, is largely to be figured from preliminary sampling and when conditions of the deposit are clearly realized.

In well-planned development work, samples should be taken frequently so as to give the operator some idea of the operation he is directing. In a drift or shaft, it would be best to sample after each round, or at regular intervals preferably not greater than five feet for erratic values and ten feet or more if the deposit is known to be quite uniform. It is well to begin with a short interval at the first sampling which may be increased as the nature and distribution of values are established. The sample results should be plotted on a compass-tape map making an assay map with necessary cross-sections and a brief report which is indispensable for the official examination, appraisal, sale, or further development of the property. For a brief and practical discussion in this respect, the owner of a small gold-lode deposit would do well to consult the United States Bureau of Mines Information Circular No. 6748.[3]

Sampling has to be executed with mining problems kept in mind at all times. It is known that it is best to carry a drift on at least one well-developed wall, but it must be established if any values lie back of this wall, and if so, are they worth going after? It is important to determine if a gouge is developed from vein or wall-rock material and whether it carries values. It may be sampled separately. The application of sampling for estimating ore reserves is beyond the scope of this paper and the reader should seek other sources of information.[4]

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[3] "Essentials for a Preliminary Report on a Small Lode-Gold Mine or Prospect, with Notes on Sampling," by C. W. Wright.

[4] "Sampling and Estimation of Ore Deposits," U. S. Bureau of Mines Bulletin No. 356, part 3, pages 114–150: Underground Sampling on pages 74–113.
Hoover, T. J., Economics of Mining, pp. 107–126, 1933.

PICK SAMPLING

Pick sampling is best applied to a mine working under the course of development and taken after each round. The samples consist of rock chipped more or less at random from the face to be sampled and are supposed to represent certain amounts of material of each sort in proportion approximately as each sort is exposed and from points well scattered over the face. The face is cleaned in advance, as in channel sampling, and a pick or moil may be used in taking the samples. As practiced in gold deposits where the mineralized width commonly varies in type, samples would be obtained by picking off bits of ore the full exposed length of each sort or band of material in the face. The material of each sort would be a separate sample or combined to make a composite sample. The width of each band is measured at right angles to the dip, and these widths are used for weighing the values when combining them in estimating the average grade at each face. An example of this practice is indicated in the Figure II.

A special type of sampling, which may be considered as a combination of channel and pick sampling, is called sheet sampling. This would consist of cutting the whole face as in a drift or raise for the sample. It is easily seen, however, that such a sample would give no idea of the relative distribution of gold values and that it is a superfluous and unnecessary method of taking a sample.

UNDERGROUND DRILL SAMPLING

Drill sampling as applied underground usually consists of collecting the cuttings from an ordinary rock drill for a sample. This type of sampling is not to be used exclusively as a method of sampling, but it is well to practice it in addition to cut sampling in order to determine the existence of commercial ore which might otherwise be overlooked behind drift walls as parallel structures and as a guide to stoping.

The sample is caught in a pan or empty powder box placed on the floor below the drill, and the cuttings allowed to flow from the drill hole into the container. The cuttings settle out and the water overflows. With this method, however, care must be taken that as little material as possible is lost by not getting into the container. Dry cuttings may be caught by holding a box or sack immediately below the drill.

GRAB SAMPLING

Grab samples consist of grabbing handfuls or scoopfuls of material selected from several points on a muck pile, from a chute, or from the top of a mine car or skip. They are usually taken haphazardly and often give very misleading results. The human tendency is to select the best material and an endeavor to counteract this may lead to the addition of too much poor material. The finer material is often not recovered by this method and the sample may not be a true representative.

BULK SAMPLING

Bulk sampling is commonly the only type of sampling that will adequately represent the average grade of the ore. The sample may consist of a few tons to several hundred tons of ore shot down from drift backs or stopes and then put through a pilot mill. The gold recovered, plus the loss in tailings which are sampled and assayed, gives the total amount of gold in the ore. This figure divided by the tonnage will give the grade of the ore per ton. This practice is the proper procedure after systematic sampling has been done in order to ascertain, in a practical way, the total recovery that can be expected before too much money has been invested in a mining property, and is especially necessary for large bodies of low-grade ore.

HANDLING AND TREATMENT OF SAMPLES

In the case of large samples, it is best to break the larger fragments by hand and to roll and quarter the sample on the property to avoid the transport of unnecessary weight. The reject may be mortared and panned as a preliminary and quick means of gaining some idea of the ore. Crushing, rolling and quartering a sample, is commonly known as ''bucking down'' and an attempt is made in this process to crush the material progressively from a coarser to finer size, roll and quarter each size, and take opposite quarters to reject half of the sample each time. Necessarily, a sample should be free of moisture.

Rolling a sample consists of thoroughly mixing the sample by rolling it back and forth on a heavy tight woven cloth or canvas. This is done by picking up alternately opposite corners of the cloth and rolling the sample, not sliding it, from one side to the other until thoroughly mixed. When complete, the material is left as a conical pile in the center of the rolling cloth.

Quartering consists of cutting conical piles of the rolled sample into four parts. First, the sample is cut in half by raising a stick or pinching up the cloth on opposite sides at the middle of the pile, raising it, and causing it to fall into two parts. This is repeated at right angles and the sample is quartered. Opposite quarters are then taken for the next sample and the rest is rejected. Samples should be placed immediately in a canvas or tightly woven cloth bag, tagged with a number to correspond with the description in the field notebook and sealed tight. A tight woven material is absolutely essential in order that all of the sample including the finer particles are retained. Care must be taken at all times to watch the sacked samples so that they do not become salted.

Free-milling ore samples which are not taken for fire assay may be panned for their approximate values. A certain amount of material is mortared and carefully panned and an estimate made from the showing of colors. This method, however, is limited entirely to free-milling, oxidized ore and if practiced where primary minerals such as sulfides are present in the ore, the determination is difficult and unsatisfactory. It is, however, a good practice in any type of ore if a quick and preliminary idea of the ore is wanted and may be a valuable guide in the pilot sampling of property. An experienced eye and good judgment are essential in making an even approximate estimate of gold values from panning. The fire assay offers the only reliable and accurate method of gold determination. Often the neglect of spending a few dollars for assays in mining ventures has resulted in a material loss and even failure of the enterprise.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

Mr. George D. Nordenholt of Los Angeles has been appointed as Director of the Department of Natural Resources, by His Excellency, Governor James Rolph, Jr.; and Mr. D. H. Blood, who has filled that office for the past three years, takes the position of Deputy Director. Mr. Nordenholt's technical training was obtained at the University of Chicago, University of Wisconsin, and Colorado School of Mines. As a mining engineer he has been identified with metal mining and petroleum operations in the West for a number of years. He is a member of the American Institute of Mining and Metallurgical Engineers.

New Publications

'California Journal of Mines and Geology' (quarterly), July-October, 1933, being Chapters 3 and 4 (combined) of the State Mineralogist's Report XXIX, is in press and will be ready for distribution at an early date.

Commercial Mineral Notes, Nos. 127, 128, 129, November, December, 1933, and January, 1934, respectively. These 'notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for "California Journal of Mines and Geology." As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to two pages in recent months.

Mails and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

CALIFORNIA'S MINERAL PRODUCTION IN 1933

The total value of the mineral production of California for the year 1933, just closed, is conservatively estimated by the statistical section of the State Division of Mines, to have been $205,525,000. This is, in part, detailed in the tabulation below, but as there are more than 50 mineral substances on California's commercial list, it is impracticable at this early date to obtain definite figures on other than the more important items. The blank report forms are being mailed to the operators in all mineral lines, and the detailed and complete report will be compiled and published later.

The estimated total of $205,525,000 is an increase of approximately $6,239,000 over the value of 1932 production, which was valued at $199,096,493. The largest increases in value of outputs over the previous year were shown by gold and cement; with lesser increases by miscellaneous stone, quicksilver, brick and hollow building tile, industrial materials and salines. The only important mineral substances which show decreased production and value are natural gas, copper, silver and lead.

The value of the petroleum output was approximately the same, although the quantity of about 173,334,000 barrels showed a decrease of 2.5 per cent from that of 1932. On March 5th there was a cut in price of all grades of crude oil, which continued until June 26th when there was an increase, to be followed by other increases on September 6th and December 1st, giving an average price slightly higher than in 1932.

Receipts of bullion at the mint, smelters and that for foreign shipments showed an increase in production of gold of some 23,000 fine ounces over 1932. To place a value on the 1933 gold output is extremely difficult as up to August 12th the metal was sold at the statutory price of $20.67; from August 12th to August 29th gold ores, concentrates, precipitates and amalgam, but no bullion could be exported at the world price. From August 29th to October 25th newly mined gold was received at the mint by the Government, who acted as selling agent for the producer and received for him approximately the London price. An Executive Order of October 25th, ordering the Reconstruction Finance Corporation to buy newly mined gold at a price fixed by the U. S. Treasurer. At $20.67 an ounce the gold output would be worth $12,452,000 but the value received was higher, probably averaging $24 an ounce, which would make the year's output worth approximately $14,218,000. Of the other metals, quicksilver showed an increased value. Zinc and molybdenum ores were mined, which were not in 1932.

The structural group showed an increase headed by cement and followed by miscellaneous stone in lesser amount. This increase might be accounted for by the large amount of construction by public works. Both the industrial and saline groups showed a trend to increased values.

The estimated values and quantities for 1933 are as follows:

$14,218,000	gold (592,400 fine oz.)
122,000	(353,000 fine oz.) silver
73,000	(1,145,000 lbs.) copper
26,000	(704,000 lbs.) lead
292,000	(5,100 flasks) quicksilver
16,000	other metals, including molybdenum, tungsten, and zinc.
143,011,000	(173,334,000 bbls.) petroleum
14,840,000	(257,200,000 M. cu. ft.) natural gas
10,211,000	(7,042,000 bbls.) cement
8,469,000	crushed rock, sand and gravel
1,800,000	brick and hollow building tile
967,000	other structural materials, including bituminous rock, granite, magnesite, marble, etc.
4,000,000	miscellaneous industrial minerals
7,500,000	salines, including borax, potash, salt, soda, etc.
$205,525,000	Total

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Beside its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

During 1933 there were 54,825 people who visited the Museum and Library of the Division of Mines in San Francisco. Among these there were many men who were forced by conditions to find new means of livelihood, and resorted to prospecting. They were able to observe here how all minerals, ores and rocks appear, thereby having a better knowledge of what they will find in the hills; also what minerals and rocks look like as described in various reports and books.

LABORATORY

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpose of identifying minerals and making qualitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this State department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is often able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector. Very small pieces of certain silicates, such as andalusite, have been supplied to those desiring them.

Determinations made by the Division of Mines during 1933 totaled 6498. Prospecting and exploitation of the State's mineral wealth increases as the State becomes more thickly populated. Each year new occurrences of some mineral in the State are reported and occasionally a new mineral species is found. New uses for a mineral are frequently found, and as a result stimulus is given to searching for that particular substance.

In the present economic distress many are seeking through hand methods of placer mining the wherewithal to purchase even food for themselves. Besides some 10,000 separate pieces of printed matter covering such information supplied through the offices of the Division of Mines, a total of 1200 persons were taught and had demonstrated the rudiments of placering last year in the laboratory of the Division in San Francisco.

LIBRARY

HERBERT A. FRANKE, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED

Government, National

U. S. Geological Survey:

Bulletins:

842 —Metalliferous Deposits of The Greater Helena Mining Region, Montana. By Pardie and Schrader.
845 —Guidebook of the Western U. S.; Part F—Southern Pacific Lines, New Orleans to Los Angeles. By N. H. Darton.
846-A—Some Mining Districts of Eastern Oregon. By Gilluly, Reed and Park.
846-B—Geology and Ore Deposits of the Takilma-Waldo District, Oregon. By P. J. Shenon.
849-B—Lode Deposits of the Fairbanks District, Alaska. By James M. Hill.
849-C—The Willow Creek Lode District, Alaska. By J. C. Ray.
849-E—Mineral Deposits Near the West Fork of the Chulitna River, Alaska. By C. P. Ross.
849-F—Lode Deposits of Eureka and Vicinity, Kantishna District, Alaska. By F. G. Wells.
849-H—The Valdez Creek Mining District, Alaska. By C. P. Ross.
849-I —The Moose Pass-Hope District, Kenai Peninsula, Alaska. By R. Tuck.

Professional Papers:

175-D—Origin of the Anhydrite Cap Rock of American Salt Domes. By M. I. Goldman.

Water Supply Papers:

639 —Geology and Ground-Water Resources of the Roswell Artesian Basin, New Mexico.
656 —Ground-Water Resources of Western Tennessee.
729 —Part 4—St. Lawrence River Basin.
730 —Part 5—Hudson Bay and Upper Mississippi River Basins.
731 —Part 6—Missouri River Basin.
732 —Part 7—Lower Mississippi River Basin.
734 —Part 9—Colorado River Basin.
735 —Part 10—The Great Basin.
736 —Part 11—Pacific Slope Basins in California.

U. S. Geological Survey:

Circulars:

2 —Copper Deposits in the Squaw Creek and Silver Peak Districts and at the Alameda Mine, S. W. Oregon; with notes on the Pennell and Farmer and Bonfield Properties. By P. J. Shenon.

U. S. Geological Survey:

Circulars:

3 —The Bleaching Clays. By P. G. Nutting.
4 —Some Deposits of Ornamental Stone in Montana. By G. R. Mansfield.
6 —Mineral-Water Supply of the Mineral Wells Area, Texas. By S. F. Turner.

U. S. Bureau of Mines:

Bulletins:

368 —Static Electricity in Nature and Industry. By P. G. Guest.
373 —Coal-Mine Accidents in the U. S.: 1931. By Adams, Geyer & Chenoweth.
374 —Metal Mine Accidents in the U. S., 1931. By W. W. Adams.
375 —Quarry Accidents in the U. S., 1931.

Economic Papers:

16 —Potash.

Technical Papers:

548 —Carbonizing Properties and Constitution of No. 2 Gas Bed Coal from Point Lick No. 4 Mine, Kanawha Co., W. Va.
551 —Safety at Petroleum Cracking Plants. By R. L. Marek.
554 —Solubility and Liberation of Gas from Natural Oil-Gas Solutions. By B. E. Lindsly.
555 —Viscosity of Natural Gas. By Berwald & Johnson.
558 —Production of Explosives in the U. S., 1932.
559 —Coke-Oven Accidents in the U. S., 1932.
560 —Corrosion of Steel by Gases Containing Traces of Hydrogen Sulphide: Effect of Pressure and Moisture Conditions. By Devine, Wilhelm & Schmidt.

Mineral Resources of the United States:

Cement in 1931.
Copper in 1931.
Crude Petroleum and Petroleum Products in 1931.
Gold and Silver in 1931.
Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1931.
Gold, Silver, Copper, Lead and Zinc in Colorado in 1931.
Gold, Silver, Copper, Lead and Zinc in Nevada in 1931.
Gold, Silver, Copper, Lead and Zinc in Utah, in 1931.
Phosphate Rock in 1931.

Report of Investigations:

3210—A Study of the Properties of Texas-New Mexico Polyhalite Pertaining to the Extraction of Potash.

VII. Effect of Particle Size, Sodium Chloride Concentration, and Temperature Upon Hot Extraction by a Multistage Process. By J. E. Conley and F. Fraas.
3213—Investigations During 1932 of Combustibles in Manholes in Boston, Mass. By G. W. Jones, John Campbell and F. M. Goodwin.
3215—Comparison of Methods for Determining the Friability of Coal. By H. F. Yancey and R. E. Zane.
3217—Estimate of the Gas Reserves of the Oklahoma City Oil Field, Oklahoma County, Okla. By H. B. Hill and E. L. Rawlins.
3218—Volatilization of Impurities from Zinc Concentrates, by G. L. Oldright, W. E. Keck, and F. K. Shelton, with a chapter on Thermodynamic Calculations, Further Theoretical Study of the Separation of Cadmium and Zinc by C. G. Maier.
3219—The National Safety Competition of 1932. By W. W. Adams.
3220—Active List of Permissible Explosives and Blasting Devices Approved Prior to June 30, 1933.
3221—Consumption Trends in the Roofing Slate Industry. By Oliver Bowles.
3222—Survey of Fuel Consumption at Refineries in 1932. Reprinted from U. S. Bureau of Mines Report of Investigations. By G. R. Hopkins.

Information Circulars:

6722—Timber Withdrawing and Devices Used for This Purpose in Some Coal Mines. By J. W. Paul and J. G. Calverley.
6723—Limestone, Part 1—General Information. By Oliver Bowles, and D. M. Banks.
6727—Factors and Conditions That Aid in Alinement of Pillar Extraction Lines in Coal Mining. By J. N. Geyer.
6729—Manganese. General Information. By Robert H. Ridgway.
6730—Design, Equipment, and Construction Costs of the Davis-Dunkirk Concentrator, Prescott, Ariz. By E. L. Sweeney.
6731—Accident Prevention at the New Black Diamond Coal Mine, Washington. By S. H. Ash and R. W. Smith.
6732—Recomendations of the U. S. Bureau of Mines on Certain Questions of Safety as of February 3, 1933. By The Mine Safety Board.
6733—Evolution of Methane Detecting Devices for Coal Mines. By L. C. Illsley and A. B. Hooker.
6735—Cost of Equipping and Developing a Small Gold Mine in the Bradshaw Mountains Quadrangle, Yavapai County, Arizona. By David C. Minton, Jr.
6736—Mining Methods and Costs at the Teziutlan Copper Mine of the Mexican Corporation, S. A., Teziutlan, Puebla, Mexico. By Ernest Ph. Herivel.
6737—Petroleum and Natural-Gas Studies of the U. S. Bureau of Mines. By H. C. Fowler.
6738—Blasting Practices as They Affect the Roof of Coal Mines in Ohio, Pennsylvania, and West Virginia. By J. N. Geyer.
6739—Milling Methods and Costs at the Golden Cycle Mill, Colorado Springs, Colo. By L. S. Harner.
6740—Economic Aspects of Gold and Silver. By Scott Turner.
6741—Mining Methods and Costs at the McIntyre Porcupine Mines, Ltd., Schumacher, Ontario. By H. G. Skavlem.
6742—Milling Methods and Costs at the Concentrator of the Premier Gold Mining Co., Ltd., Premier, B. C., Canada. By D. L. Pitt, W. J. Asselstine, and D. L. Coulter.
6743—Safety Practices and Achievements at the Columbia Mine of the Columbia Steel Co. (Subsidiary of the U. S. Steel Corp.). By D. J. Parker.
6744—Methods and Costs at the Granite Quarry and Crushed-Stone Plant of the Weston & Brooker Co., Cayce, S. C. By T. I. Weston.
6745—About Helium. By Andrew Stewart.
6746—A Review of Coal-Mine Fatalities in Indiana During the Fiscal Year October 1, 1931, to September 30, 1932. By C. A. Herbert.
6747—Use of Electric Power in Castle Gate No. 2 Mine, Utah Fuel Co. By D. J. Parker.

6748—Essentials for a Preliminary Report on a Small Lode-Gold Mine or Prospect, with notes on sampling. By Chas. Will Wright.
6749—Markets for Residential Stone. By Paul Hatmaker.
6750—Mining Laws of the Irish Free State. By E. P. Youngman.
6751—Onyx Marble and Travertine. By Oliver Bowles and D. M. Banks.
6752—Explosions in Utah Coal Mines, 1900–1932. By D. J. Parker.
6753—Explosions in Colorado Coal Mines, 1883, to 1932. By B. M. Kintz and E. H. Denny.
6755—The Experimental Mine of the U. S. Bureau of Mines. By G. S. Rice, H. P. Greenwald and H. C. Howarth.
6756—Limestone, Part II, Dimension Stone. By Oliver Bowles.
6758—Milling Methods at the Lead Zinc Concentrator of the International Smelting Co., Tooele, Utah. By W. J. McKenna.
6759—Milling Methods at the Oxide Concentrator of the International Smelting Co., Tooele, Utah. By J. J. Bean.

Government, State

Arizona Bureau of Mines, Tucson:

Bulletin 134—Geology and Mineral Deposits of Southern Yuma Co., Arizona. By E. D. Wilson.

California State Department of Public Works, Sacramento:

"California Highways and Public Works."

California State Division of Fish and Game, San Francisco:

"California Fish and Game."

California State Library, Sacramento:

"News Notes."

Colorado Bureau of Mines, Denver:

Annual Report for the year 1932.

Idaho Bureau of Mines & Geology, Moscow:

39—The Dome Mining District, Butte Co., Idaho. By C. P. Ross.

Illinois State Geographical Survey, Urbana:

R. I. 30—Oil and Gas Possibilities of parts of Jersey, Grane and Madison Counties. By D. M. Collingwood.
R. I. 31—Briquetting Illinois Coals Without a Binder by Compression and by Impact. By R. J. Piersol.

Kansas State Geological Survey, Lawrence:

Circular No. 5—Preliminary Report on the Ground Water Resources of the Shallow Water Basin in Scott and Finney Counties, Kansas. By R. G. Moss.
Circular No. 19—The Geology of Ness and Hodgeman Counties. By R. G. Moss.
Louisiana Department of Conservation, New Orleans:
Geological Bulletin No. 3—Geology of Lafayette and St. Martin Parishes. By H. V. Howe and C. K. Moresi.

Maine Geological Survey:

Preliminary Geologic Map of Maine, 1933. By A. Keith.

Michigan Geological Survey, Lansing:

R. I. 29—Electric Condenser Process for Demulsifying Oil. By R. J. Piersol.
Pub. 38—Oil & Gas Fields of Michigan. By R. B. Newcombe.

Minnesota Geological Survey, Minneapolis:

The Geology of the Rove Formation and Associated Intrusives in Northeastern Minnesota. By F. F. Grount and G. M. Schwartz.
The Limestones and Marls of Minnesota. By C. R. Stauffer and G. A. Thiel.
Geological Map of the State of Minnesota.
Montana Bureau of Mines and Geology, Butte.
Memoir No. 9—A Geological Reconnaissance of the Tobacco Root Mountains, Madison County, Montana. By Tansley, Schafer and Hart.
Memoir No. 10—Some Gold Deposits of Broadwater, Beaverhead, Phillips, and Fergus counties, Montana. By A. V. Corry.

Nebraska Geological Survey, Lincoln:

Bulletin 8—The Ostracoda of the Big Blue Series in Nebraska. By M. E. Upson.

Bulletin 9—The Nautiloid Cephalopods of the Pennsylvanian System in the Mid-Continent Region. By Miller, Dunbar and Condra.

Paper No. 1—The Grenola Formation. By Condra & Busby.

Paper No. 2—The Missouri Valley Traverse in Iowa, North of the Jones Point Deformation. By G. E. Condra.

Paper No. 3—The Red Oak-Stennett-Lewis Traverse of Iowa. By Condra and Upp.

Paper No. 4—The Middle River Traverse of Iowa. By Condra and Upp.

Paper No. 5—Faunal Lists of the Tertiary Vertebrata of Nebraska and Adjacent Areas. By H. J. and M. C. Cook.

Nevada State Bureau of Mines, Reno:

Vol. XXVII, No. 3—Geology of the Tybo District, Nevada. By H. G. Ferguson.

North Dakota Geological Survey, Grand Forks:

Bulletin 6—A method of Water Prospecting. By H. E. Simpson.

South Dakota State Geological Survey, Vermillion:

R. I. No. 15—Prospecting for Placer Gold in South Dakota. Compiled by D. L. M. Anderson.

R. I. No. 16—Geologic History of Black Hills Gold Placers. By J. P. Connolly.

Virginia Geological Survey, University:

Bulletin 41—Preliminary Report on Ground Water in Northern Virginia. By R. C. Cady.

Bulletin 42—Geologic Map of the Appalachian Valley of Virginia with Explanatory Text. By C. Butts.

Government, Foreign

Alberta Research Council, Edmonton:

Annual Reports.

Argentina Direccion General de Minas y Geologica, Buenos Aires:

Publications.

South Australia Department of Mines, Adelaide:

Annual Reports, Mining Reviews, etc.

British Columbia Department of Mines, Victoria:

Bulletin No. 2—Summary and Review of the Mineral Industry of British Columbia, to June 30, 1933.

Geological Survey of Great Britain, London:

Memoirs, Geologic Maps, etc.

Museo de Historia Natural de Montevideo, Uruguay:

Analas.

Secretaria de Industria, Comercio y Trabajo, Mexico, D. F.;

Boletin Minero.
Boletin del Petroleo.

New Zealand Geological Survey Branch, Wellington:

Reports.

Nova Scotia Department of Public Works and Mines, Halifax:

Annual Reports.

Ontario Department of Mines, Toronto, Canada:

Annual Reports.

Quebec Bureau of Mines, Quebec, Canada:

Reports.

Queensland Department of Mines, Brisbane, Austraiia;
Annual Reports.

Instituto Historica e Geographico, Brasilerio de Janeiro:
Publications.

New South Wales Department of Mines, Sydney, Australia:
Annual Reports.

Transvaal Chamber of Mines, Johannesburg, So. Africa:
Publications.

British Museum, London:
The Cephalospids of Great Britain. By E. A. Stensio.

Canada Department of Mines, Ottawa:
Gold in Canada, 1933. By A. H. A. Robinson.

Geological Service of Minas Geraes, Bello Horizonte, Brazil:
Publications.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain:
Memoiras.

Academy of Natural Sciences of Philadelphia:
Proceedings.

American Association of Petroleum Geologists, Tulsa, Oklahoma:
Bulletins.

American Geographical Society of New York.
"Geographical Review."
American Journal of Science, New Haven, Conn.

American Philosophical Society, Philadelphia:
Proceedings.

Australian Museum, Sydney.
Records.

California Academy of Sciences, San Francisco:
Proceedings.

Canadian Institute of Mining and Metallurgy, Montreal:
"Canadian Mining and Metallurgical Bulletin."

Cleveland Museum of Natural History, Cleveland, Ohio:
Scientific Publications.
Colorado College Publication, Colorado Springs.

Colorado Scientific Society, Denver:
Proceedings.

Commonwealth Club, San Francisco:
Journals.
Economic Geology, Lancaster, Pa.

Field Museum of Natural History, Chicago:
Geological Series.

Franklin Institute of the State of Pennsylvania, Lancaster, Pa.:
Journals.

Geological Society of America, Columbia University, New York:
Bulletins.

Geological Society of London:
Abstracts of the Proceedings.

Institution of Mining and Metallurgy, London:
  Bulletins, Transactions.

Instituto Geologico de Mexico, Mexico, D. F.:
  Bulletins.
Journal of Geology, Chicago.

Library of Congress, Washington, D. C.:
  Monthly Check List of State Publications.

Los Angeles Junior College, Los Angeles:
  No. 1—Geological Journeys in Southern California. By A. Livingston, Jr., and Wm. C. Putnam.

Mineralogical Society of America, Menasha, Wisconsin:
  "The American Mineralogist."

Mining and Metallurgical Society of America, New York:
  Bulletins.

Museu Nacional, Rio de Janeiro:
  Boletins.

New York Academy of Sciences, New York:
  Annals, etc.

New York State Museum, Albany:
  Publications.

Northwest Scientific Association, Cheney, Wash.:
  "Northwest Science."

Pennsylvania State College, State College:
  Bulletins.
Philippine Journal of Science, Manila.

Royal Society of South Australia, Adelaide:
  Transactions and Proceedings.

Seismological Society of America, Stanford University:
  Bulletins.

Sierra Club, San Francisco:
  Bulletin.

Society of Economic Paleontologists and Mineralogists, Ft. Worth, Texas:
  "Journal of Paleontology."

Southern California Academy of Sciences, Los Angeles:
  Bulletins.

Stanford University, California:
  Abstracts of Dissertations.

Texas Technological College, Lubbock.
  Bulletins.

University of California, Berkeley:
  Publications in Engineering:
    Vol. 3, No. 2—Tests on Structural Models of Proposed San Francisco-Oakland Suspension Bridge. By Beggs, Davis and Davis.
  University of California, Department of Geological Sciences:
    Vol. 23, No. 3—The Fauna of the Type Blakely Upper Oligocene of Washington. By N. M. Tegland.
    Vol. 23, No. 6—Mount Thielson, A Dissected Cascade Volcano. By H. Williams.
    Vol. 23, No. 7—The Tuscan Formation of Northern California. By C. A. Anderson.
      Department of Geography:
    Vol. 6, No. 4—Marquesan Meteorology. By J. B. Leighly.

University of Florida, Gainesville:

The Mapping Situation in Florida.

Washington School of Mines and Geology:

I. C. 2—The W. S. C. Placer Mill. By G. E. Ingersoll.

Books

Earth History. By L. C. Snider.
The Economics of Mining. By T. J. Hoover.
The Story of Inyo. By W. A. Chalfant.
Gold Mining—Opportunities and Pitfalls. By L. A. Palmer.
Interviews with Mining Engineers. By T. A. Rickard.
Lost Mines of the Great Southwest. By J. D. Mitchell.
Manganese for National Defense. By American Institute of Mining and Metallurgical Engineers.
Mine Foremanship. By Dr. J. J. Rutledge.
The Mineral Industry during 1932. Vol. 41.
Minerals Yearbook, 1932–33.
Ore Deposits of the Western States. American Institute of Mining and Metallurgical Engineers.
Process Industries Handbook of Corrosion Resistant Materials.
Weights of Materials. By the General Engineering Co.

Maps

U. S. Geological Survey Topographic Maps:

California:

Avenal Gap Quadrangle.
Bear Mountain Quadrangle, Kern County.
Casa Desierta Quadrangle, Los Angeles County.
Coyote Hills.
El Toro Quadrangle.
Garden Grove.
Hoaglin.
Kramer Borate District.
Los Alamitos Quadrangle.
Lovejoy Springs Quadrangle, Los Angeles County.
Newhall Quadrangle, Los Angeles County.
Olinda Quadrangle.
Orange Quadrangle.
Rosedale Quadrangle, Los Angeles County.
Seal Beach Quadrangle.
West Alpine Butte Quadrangle, Los Angeles County.
White River Quadrangle.
Woody Quadrangle.

Idaho:

Craters of the Moon National Monuments.

Missouri:

St. Charles Quadrangle.

Texas:

Bolivar Point Quadrangle.
Caplen Quadrangle.
Flake Quadrangle.
Frozen Point Quadrangle.
Galveston Quadrangle.
High Island Quadrangle.
Jetties, The, Quadrangle.
Karankawa Lake Quadrangle.
Lake Como Quadrangle.
San Luis Pass Quadrangle.
Santa Rosa Quadrangle.
Smith Point Quadrangle.
Whites Lake Quadrangle.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Architect and Engineer, San Francisco.
Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Commonwealth, San Francisco.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Geophysical Prospector, Los Angeles.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pa.
Mining Congress Journal, Washington, D. C.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining Truth, Spokane, Washington.
National Sand and Gravel, Washington, D. C.
Nickel Cast Iron News, New York City.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Pit and Quarry, Chicago.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Gold Miner, Los Angeles, California.

Inland Oil Index, Casper, Wyoming.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mojave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
National Industrial Review, San Francisco, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Northern Miner, Toronto, Canada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, Cailfornia.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of MINING IN CALIFORNIA was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of *California Journal of Mines and Geology,* these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of *California Journal of Mines and Geology.*

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Coalinga, Taft, Bakersfield. They may also be found in many public, private and technical libraries in California and other States and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

Note.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00	$0.20
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:		
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50	.10
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915–1916. Fletcher Hamilton:		
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.50	.05
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----	----
**Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	----	----
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917–1918, Fletcher Hamilton:		
Mines and Mineral Resources of Nevada County, 270 pp., paper	$0.75	$0.15
Mines and Mineral Resources of Plumas County, 188 pp., paper	.50	.10
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50	.10
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75	.25
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:		
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	.25	.05
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.25	.05
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25	.05
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.25	.05
April, 1925, Mines and Mineral Resources of Calaveras, Merced, San Joaquin, Stanislaus and Ventura Counties	.25	.05
July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.25	.10
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----	----
April, 1926, Mines and Mineral Resources of Shasta, San Benito and Imperial Counties	.25	.10
July, 1926, Mines and Mineral Resources of Marin and Sonoma Counties	.25	.05
**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.25	.10
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.25	.05
July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	.25	.10
October, 1927, Mines and Mineral Resources of Mono County	.25	.05
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1928, Mines and Mineral Resources of Tuolumne County	.25	.05
April, 1928, Mines and Mineral Resources of Mariposa County	.25	.05
July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.25	.05
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.25	.05
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
**January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	----	----

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	$0.25	$0.10
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.25	.10
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.25	.10
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.25	.05
April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	.25	.05
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.25	.10
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.25	.10
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.25	.10
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.25	.10
July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	.25	.10
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.25	.05
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.25	.10
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	----	----
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits. Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.20	.05
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.50	.15
Chapters of Report XXIX, 1933 (quarterly): titled "California Journal of Mines and Geology," containing the following:		
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing		

REPORTS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties	$0.80	$0.15
July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543	.80	.10
January, Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits	.40	.10
Subscription, $1.50 in advance (by calendar year, only).		
Chapters of State Oil and Gas Supervisor's Report:		
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free	----
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:		
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----	----
January, **February, **March, April, **May, **June, **July, August, **September, **October, **November, **December, 1921	Free	----
January, February, March, April, May, **June, **July, **August, September, **October, **November, December, 1922	Free	----
January, **February, **March, **April, May, **June, **July, August, September, **October, November, December, 1923	Free	----
January, February, March, April, May, June, July, August, September, October, November, December, 1924	Free	----
January, February, March, April, May, June, **July, August, September, October, November, December, 1925	Free	----
January, February, March, April, May, June, July, August, September, October, November, December, 1926	Free	----
January, February, March, April, May, June, July, August, September, October, November, December, 1927	Free	----
January, February, March, April, **May, June, July, **August, September, **October, **November, **December, 1928	Free	----
January, February, March, April, May, June, July-August-September, October-November-December, 1929	Free	----
(Published quarterly beginning July, 1929.)		
January-February-March, April-May-June, July-August-September, October-November-December, 1930	Free	----
January-February-March, April-May-June, July-August-September, 1931	Free	----

BULLETINS

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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MINES

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FOR THE PURPOSE OF FURTHERING
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WALTER W. BRADLEY,
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STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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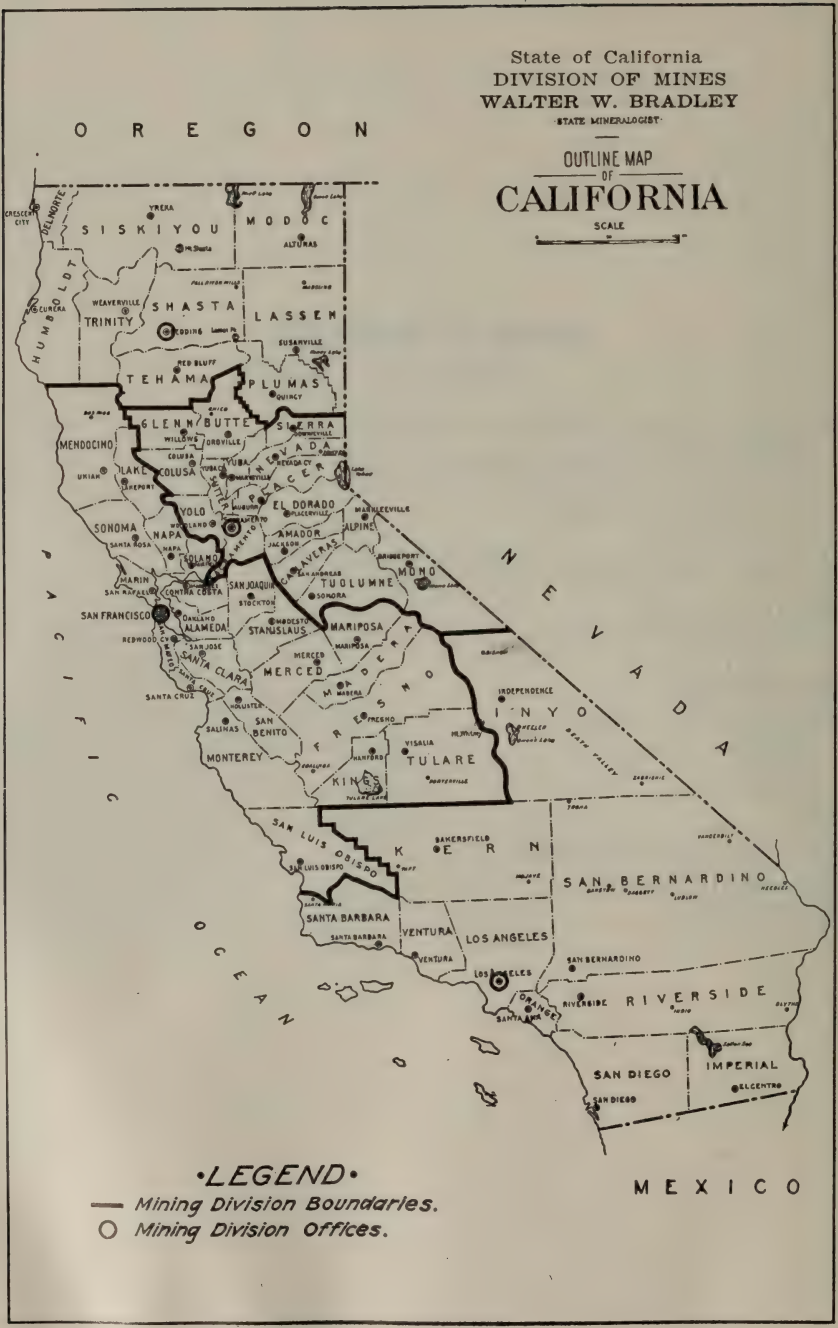
State of California
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST
OUTLINE MAP OF CALIFORNIA
SCALE
OREGON
NEVADA
MEXICO
PACIFIC OCEAN
DEL NORTE
CRESCENT CITY
SISKIYOU
YREKA
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
MENDOCINO
UKIAH
GLENN
WILLOWS
BUTTE
OROVILLE
CHICO
SIERRA
DOWNIEVILLE
NEVADA
NEVADA CY
COLUSA
LAKE
LAKEPORT
SUTTER
YUBA
MARYSVILLE
PLACER
AUBURN
YOLO
WOODLAND
SACRAMENTO
EL DORADO
PLACERVILLE
MARKLEEVILLE
ALPINE
SONOMA
SANTA ROSA
NAPA
AMADOR
JACKSON
SOLANO
CALAVERAS
SAN ANDREAS
BRIDGEPORT
MONO
MARIN
SAN RAFAEL
CONTRA COSTA
SAN JOAQUIN
STOCKTON
TUOLUMNE
SONORA
SAN FRANCISCO
OAKLAND
ALAMEDA
MODESTO
STANISLAUS
MARIPOSA
REDWOOD CY
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
FRESNO
INDEPENDENCE
INYO
DEATH VALLEY
VISALIA
TULARE
HANFORD
KINGS
TULARE LAKE
MONTEREY
SAN LUIS OBISPO
BAKERSFIELD
KERN
MOJAVE
SAN BERNARDINO
NEEDLES
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
SANTA ANA
RIVERSIDE
SAN DIEGO
IMPERIAL
EL CENTRO
•LEGEND•
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given County (describing kind, character, distribution and extent of development).

2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).

3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each division, prepared by the District Engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the State's oil fields is included under this heading.

REDDING FIELD DIVISION

CHAS. V. AVERILL, Mining Engineer

There is no report from the Redding Field Division. Mr. Chas. V. Averill, District Mining Engineer, is engaged on investigations for a special report upon the gold resources of Siskiyou County.

SACRAMENTO FIELD DIVISION

C. A. LOGAN, Mining Engineer

Mr. C. A. Logan, District Engineer, is engaged in the preparation of a special report upon the Mother Lode Gold Belt of California, which it is planned will be published soon.

SAN FRANCISCO FIELD DIVISION

C. McK. LAIZURE, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DIVISION

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

Reports covering the mines and mineral resources of all of the counties in the Los Angeles field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

GEOLOGIC BRANCH

CURRENT NOTES

OLAF P. JENKINS, Chief Geologist

Several geological reports will be ready for publication as soon as the necessary printing funds are available. The already completed manuscripts are on areas in southern California, and are listed as follows:

1. Geology and Mineral Resources of the Elizabeth Lake Quadrangle (Kern and Los Angeles Counties), by Edward C. Simpson.
2. Geological Investigation of the Graphite Deposits of Los Angeles County, by Burt Beverly, Jr.
3. Geological Investigation of the Clay Deposits of Orange and Riverside Counties, by J. Clark Sutherland.
4. Geology and Mineral Deposits of the Julian District, San Diego County, by Maurice Donnelly.

Excellent progress is now being made on the California State Geologic Map by the Geologic Branch in cooperation with the United States Geological Survey. Through funds made available by the Federal Public Works Administration, two part-time geologists, E. Wayne Galliher and Burt Beverly, have been employed by the United States Geological Survey on this large undertaking. The whole work is under the direct supervision of the Chief Geologist of the California Division of Mines. By courtesy of the Department of Geology of Stanford University, the compilation and drawing of the map is being done in the drafting room of the Department of Geology at Stanford University.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From January 1, 1934, to and including March 31, 1934, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
John F. Wilcox	11	20 S.	14 E.	1	Coalinga
Kettleman North Dome Assoc.	28	21 S.	17 E.	32	Kettleman North Dome
Kettleman North Dome Assoc.	32	21 S.	17 E.	21	Kettleman North Dome
Standard Oil Co.	33	21 S.	17 E.	6	Kettleman North Dome
Standard Oil Co.	35	21 S.	17 E.	2	Kettleman North Dome
Superior Oil Co.	29	21 S.	17 E.	Huffman 8	Kettleman North Dome
Union Oil Co.	29	21 S.	17 E.	King 6	Kettleman North Dome
HUMBOLDT COUNTY:					
Cape Mendocino Oil Co., Ltd.	21	1 S.	2 W.	1	------
KERN COUNTY:					
Belridge Oil Co.	27	27 S.	20 E.	35-27	Belridge
Belridge Oil Co.	35	27 S.	20 E.	16-35	Belridge
Western Gulf Oil Co.	21	29 S.	27 E.	Pugh 1	Fruitvale
Welport Oil Co.	26	29 S.	21 E.	105	McKittrick
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	11	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	23	Midway
Standard Oil Co.	15	32 S.	24 E.	61	Midway
Framac Oil Co.	27	26 S.	28 E.	Bohen 1	Mt. Poso
General Petroleum Corp.	21	27 S.	28 E.	Glide 21 10	Mt. Poso
Himovitz Lease Co.	21	27 S.	28 E.	3	Mt. Poso
Semaphore Petroleum Corp.	14	27 S.	27 E.	Vedder 1	Mt. Poso
Shell Oil Co.	4	27 S.	28 E.	Mathews Fee 1	Mt. Poso
Centralia Oil Co.	24	30 S.	28 E.	Centralia-Vedder 1	Mountain View
Gilmore Oil Co.	24	30 S.	28 E.	Dechent 1	Mountain View
Hogan Petroleum Co.	29	30 S.	29 E.	Mid State 1	Mountain View
Hubro Oil Corp.	30	30 S.	29 E.	Noble-Petrol 1-A	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Clendenen 2	Mountain View
Severns Drilling Co.	24	30 S.	28 E.	Smith 1	Mountain View
Severns Drilling Co.	24	30 S.	28 E.	Smith 2	Mountain View
Sovereign Oil Corp.	30	30 S.	29 E.	San Joaquin 1	Mountain View
Standard Oil Co.	19	30 S.	29 E.	Nichols Comm. 1	Mountain View
E. G. Starr	25	30 S.	28 E.	Wells Lease 1	Mountain View
Honolulu Oil Corp., Ltd.	18	28 S.	29 E.	1-A	Round Mountain
Joseph McDonald	6	11 N.	23 W.	McDonald 1	Sunset
Bankline Oil Co.	26	11 N.	24 W.	Orloff 1-A	------
Fisher & Welton	35	11 N.	23 W.	Harris 1	------
A. T. Jergins Trust	23	30 S.	29 E.	Stuart-Gerard 1	------
North American Oil Consolidated	25	25 S.	27 E.	Quinn 1	------
KINGS COUNTY:					
Standard Oil Co.	1	22 S.	17 E.	54	Kettleman North Dome
Tulare Basin Gas Co., Ltd.	2	23 S.	19 E.	2	------
LOS ANGELES COUNTY:					
Standard Oil Co.	13	3 S.	11 W.	Murphy-Coyote 117	Coyote Hills
Dominguez Oil Co.	34	3 S.	13 W.	Del Amo 1	Dominguez
John B. Quinn	3	4 S.	13 W.	Quinn 1	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 52	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 53	Dominguez
Shell Oil Co.	33	3 S.	13 W.	Reyes 54	Dominguez
Kieps Oil Co.	17	2 S.	14 W.	Sentous-Kupfer 1	Inglewood
Pacific Western Oil Co.	8	2 S.	14 W.	Cone 16	Inglewood
Scientia Oil Co.	7	2 S.	14 W.	Scientia 1	Inglewood
Albert H. Allen	19	4 S.	12 W.	5	Long Beach
Allied Petroleum Corp.	19	4 S.	12 W.	Galbraith 13	Long Beach
R. R. Bush Oil Co.	20	4 S.	12 W.	Dodge-Fee 1	Long Beach
J. H. Cochran	19	4 S.	12 W.	8	Long Beach
Concord Oil Co.	30	4 S.	12 W.	Concord 1	Long Beach
Congo Oil Co., Ltd.	30	4 S.	12 W.	Congo 1	Long Beach
Dabney-Johnston Oil Corp.	18	4 S.	12 W.	81	Long Beach
D. D. Dunlap	30	4 S.	12 W.	8	Long Beach
W. O. Dye	30	4 S.	12 W.	Dye 1	Long Beach
Edmar Oil Co.	19	4 S.	12 W.	Beauchamp 1	Long Beach
Equitable Oil Co.	20	4 S.	12 W.	Equitable 12	Long Beach
R. L. Goetz	19	4 S.	12 W.	Goetz 2	Long Beach
E. M. Harrison	20	4 S.	12 W.	1	Long Beach
A. S. Johnston Drilling Corp.	20	4 S.	12 W.	Fee 1	Long Beach
Ladden Oil Co.	30	4 S.	12 W.	Ladden 1	Long Beach
Marine Development Corp.	30	4 S.	12 W.	Hines 1	Long Beach
Medal Oil Co.	30	4 S.	12 W.	1	Long Beach

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
LOS ANGELES COUNTY—Continued					
Merco Oil Co.	19	4 S.	12 W.	Kellogg Trust 1	Long Beach
Mines Oil Co.	19	4 S.	12 W.	1	Long Beach
Myrwane Oil Corp.	20	4 S.	12 W.	1	Long Beach
Nedal Oil Co.	30	4 S.	12 W.	2	Long Beach
Petroleum Production Corp.	19	4 S.	12 W.	Mun 2	Long Beach
Rafair Drilling, Inc.	20	4 S.	12 W.	1	Long Beach
Rawco, Incorporated, Ltd.	19	4 S.	12 W.	Rawco-Decker 1	Long Beach
Selile Oil Co.	19	4 S.	12 W.	1	Long Beach
Shell Oil Co.	20	4 S.	12 W.	Andrews 9	Long Beach
Shell Oil Co.	20	4 S.	12 W.	Andrews 10	Long Beach
Shell Oil Co.	29	4 S.	12 W.	Alamitos 41	Long Beach
The State Co.	19	4 S.	12 W.	Butler 2	Long Beach
Trinity Oil Corp., Ltd.	29	4 S.	12 W.	Signal Hill 1	Long Beach
Utah Oil & Drilling Co.	19	4 S.	12 W.	Clark 1	Long Beach
Utah Oil & Drilling Co.	19	4 S.	12 W.	Seegar 1	Long Beach
Utah Oil & Drilling Co.	19	4 S.	12 W.	Stephens 1	Long Beach
Westport Oil Co.	30	4 S.	12 W.	1	Long Beach
V. R. G. Wilbur	19	4 S.	12 W.	D'Angelo 1	Long Beach
Wil-Daw Oil Co.	20	4 S.	12 W.	2	Long Beach
Wood-Callahan Oil Co., Ltd.	20	4 S.	12 W.	14	Long Beach
Woolner Oil Corp., Ltd.	19	4 S.	12 W.	L. B. Fee 4	Long Beach
Chester F. Yunker and Associates	19	4 S.	12 W.	1	Long Beach
Standard Oil Co.	6	2 S.	11 W.	Baldwin 73	Montebello
Standard Oil Co.	6	2 S.	11 W.	Temple 18	Montebello
Standard Oil Co.	6	2 S.	11 W.	Temple 19	Montebello
Standard Oil Co.	6	2 S.	11 W.	Temple 20	Montebello
The Texas Co.	6	2 S.	11 W.	Baldwin 12	Montebello
The Texas Co.	6	2 S.	11 W.	Prugh 10	Montebello
The Ohio Oil Co.	28	2 S.	15 W.	Recreation Gun Club 14	Playa del Rey
Union Oil Co.	27	2 S.	15 W.	King Vidor 5	Playa del Rey
General Petroleum Corp.	5	3 S.	11 W.	Santa Fe 46-A	Santa Fe Springs
Union Oil Co.	5	3 S.	11 W.	Farwell 5	Santa Fe Springs
Frontier Oil Co.	12	2 S.	12 W.	Kyle Unit Plan 1	
Rex Anglin Development Co.	29	2 S.	11 W.	Sallio & Carney Rex Anglin 1	
ORANGE COUNTY:					
Standard Oil Co.	18	3 S.	10 W.	Murphy-Coyote 116	Coyote Hills
Standard Oil Co.	24	3 S.	11 W.	Emery 56	Coyote Hills
Albert H. Allen	10	6 S.	11 W.	3	Huntington Beach
Albert H. Allen	10	6 S.	11 W.	5	Huntington Beach
Camroo Oil Co.	10	6 S.	11 W.	Smith 2	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	Huntington B 65	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 21	Huntington Beach
Sunset Pacific Oil Co.	10	6 S.	11 W.	Davis 2	Huntington Beach
Sunset Pacific Oil Co.	10	6 S.	11 W.	Plavan 2	Huntington Beach
SAN BENITO COUNTY:					
James Simms	10	13 S.	5 E.	Skow 1	
SAN DIEGO COUNTY:					
San Diego Gas & Petroleum Corp.	32	18 S.	2 W.	1	
SAN JOAQUIN COUNTY:					
Milham Exploration Co.	5	4 S.	5 E.	Connolly 1	
SAN LUIS OBISPO COUNTY:					
Robert A. Foster	2	32 S.	22 E.	McKee 1	
SANTA BARBARA COUNTY:					
Shell Oil Co.	32	5 N.	30 W.	Orella 2	Capitan
Barnsdall Oil Co.	15	4 N.	29 W.	88-9B	Elwood
Pacific Western Oil Co.	16	4 N.	29 W.	92-10	Elwood
Union Oil Co.	19	10 N.	32 W.	Rice 1	
VENTURA COUNTY:					
H. A. Ivers	1	4 N.	20 W.	11	Sespe
General Petroleum Corp.	28	3 N.	23 W.	Notten 13	Ventura
Property Service Corp., Ltd.	24	3 N.	23 W.	Dabney-Lloyd 3	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

ELEMENTARY PLACER MINING IN CALIFORNIA
and
NOTES ON THE MILLING OF GOLD ORES

By C. McK. Laizure, District Mining Engineer,
with Contributions by
H. H. Symons, Frank Sanborn and H. A. Franke

OUTLINE

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INTRODUCTION

The gold mining history of California began with finding of gold nuggets in the tail race of Sutter's saw mill on the American River, near Coloma, by James W. Marshall, January 24, 1848; although a little gold had previously been obtained from stream gravels near Los Angeles at least as early as 1841. In the 12 years from 1850 to 1861 inclusive, the annual production of the State did not fall below $41,000,000, the greatest production being made in 1852 when it amounted to $81,294,700. From 1863 to the end of the World War in 1918, the annual output averaged around $16,000,000 to $17,000,000. Beginning in 1918, due largely to increasing costs of production, there was a falling off in gold mining, and the output gradually became less, reaching a low of $8,526,703 in 1929.

The year 1929 witnessed the beginning of the present world-wide economic crisis, and resultant business depression, with millions of men thrown out of employment and left facing bread lines. It also witnessed the beginning of a new phase in the history of gold mining, or perhaps it should be said, a return to its oldest phase—the recovery of gold from surface placers by individuals, with pan, rocker and sluice box. The exodus began in 1930, and not only in California, but in all western mining States, the streams and gulches soon were lined with a new generation of young and middle-aged 'amateur' gold miners.

Mechanics, salesmen, bookkeepers, chauffeurs, clerks, stenographers—for the role of novice 'gold diggers' included women and children—made up the list.

Increasing numbers joined in this work during the seasons of 1931 and 1932. The number engaged in small-scale placering in 1933 remained about the same as in 1932, as government-made work, including the CCC and CWA lessened unemployment to some extent; but during 1933 another factor developed affecting all branches of gold mining. After August 12th, gold could be sold at the world's open market price, which ranged upward from $29.25 an ounce to over $34 an ounce by the end of the year. On January 31, 1934, the official mint price was set at $35 an ounce. This price, and the curtailment of CCC and CWA work will undoubtedly induce many who have gained some experience during the past three years, and others as well, to turn to placer mining during 1934.

Increased activity in all branches of gold mining has augmented California's gold production annually since 1929, as shown by the following tabulation:

Year	Value
1929	$8,526,703
1930	9,451,162
1931	10,814,162
1932	11,765,726

The estimated value of the 1933 production figured at the old price of $20.67 is $12,245,995 but on the basis of price actually received, it will be approximately $14,217,600.[1]

Small placer operations in old Grant Gravel Pit at Friant, Fresno County, California, June, 1932. Photo by Walter W. Bradley.

A substantial portion of the annual increase in production of gold since 1929 undoubtedly is due to the accumulated 'dust' of the many individuals and small groups who worked with pan, rocker, sluice box or dry washer, on bars, in stream beds and gulches, or in the arid regions throughout the gold-bearing areas of the State. Data gathered in 1932 indicate that the 12,000 to 15,000 engaged in this work during that year recovered a total of $500,000 in gold, during an average working period of 100 days. The output by individuals in 1933 is estimated to have been $700,000.

It is true the individual's return is small, averaging less than 50¢ per day, per person, but usually it is enough to buy 'grub and overalls' and incidentally the gold-seeker gets a healthy holiday from the city. Naturally, earnings will vary with each one's location, energy, experience, equipment, and to no small degree, luck.

All must learn the knack of recovering the precious flakes and grains from the gold-bearing sand and gravel, and government agencies have been swamped with requests for information as to where placer gold may be found, how it can be saved, where sold, manner of locating claims and many other related questions.

As an aid to the novice and those with little experience or technical training 'Mining in California' April 1932, quarterly chapter of State Mineralogist's Report XXVIII, was devoted to a series of articles on these subjects. The edition of 3000 copies was exhausted in three weeks. A second edition (reprint) of 3000 copies was not sufficient to meet the demand and two short supplementary mimeographed pamphlets were issued. Over 3000 copies of the latter were also distributed.

Continued demand caused the issuance in June, 1933, of an edition of 3000 copies of a revised abstract of the April, 1932, quarterly, a mimeographed pamphlet of 41 pages, as a further contribution to the numerous bulletins and booklets that had since appeared from the press of Federal and State bureaus and private publishers. This latter 'abstract' is likewise now out of print.

During 1933 a distinct trend toward the more permanent 'quartz mining' has been noted, and with gold selling at $35 per fine ounce, many old quartz mines, prospects and dumps are now being worked, often by those with little capital or experience.

The present article has been prepared and is offered as a compendium of useful information and practical instruction for those who voluntarily or through force of circumstances, are turning to gold mining, either placer or quartz, as a means of livelihood. It is in no sense a treatise on placer mining, quartz mining, or milling, but it is hoped will prove a useful guide, particularly to residents of the State who are more or less familiar with conditions here. It is intended also as a warning. In spite of alluring tales that have appeared from time to time in various periodicals and movie news-reels, the average earnings from hand placer mining are in fact very meager. No one should start out without having enough funds to carry him through, if necessary, and there is no inducement whatever for those who lack funds and experience to come to California for such work.

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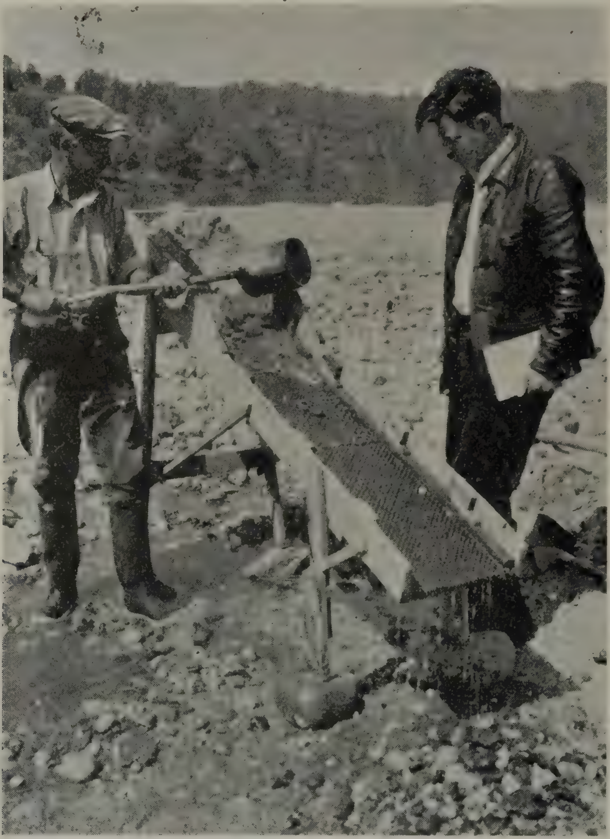
[1] U. S. Bureau of Mines Mineral Market Report M.M.S. 246.

Various suggestions have been made to both Federal and California State officials regarding the grubstaking of individuals for small-scale hand placer mining. These various proposals have been given sympathetic hearings but up to the present time no definite steps have been taken by State or Nation to put any of them into effect. If the State should undertake such a program as an emergency measure, which appears very doubtful, it would most certainly be confined to residents of this State. If undertaken by the Federal government any plan devised would naturally include all of the western gold-mining States.



A dip-box, or short sluice, with iron screen for riffles.
Photo by Thos. White.

TYPES OF PLACER DEPOSITS

Both deep-seated or ancient buried-river channel deposits and surface placers are found in California. The amateur gold seeker will be interested chiefly in surface placers. These may be divided into residual placers in which the gold and decomposed rock are left in approximately their original location, and transported placers which result from the removal of the gold-bearing material from its original source, mainly by running water, and its redeposition at some distant point. The latter type are the more important sources of placer gold. These transported placer deposits have been classified as follows:[1]

Creek placers. Gravel deposits in the beds and intermediate flood plains of small streams.

Bench placers. Gravel deposits in ancient stream channels and flood plains which stand from 50 to several hundred feet above the present streams. They represent the remnants of the stream beds during earlier stages of stream development.

Hillside placers. A group of gravel deposits intermediate between the creek and bench placers. Their bedrock is slightly above the creek bed and the surface topography shows no indication of benching.

Gold pan. Finishing. Photo by Thos. White.

River-bar placers. Placers on gravel flats in or adjacent to the beds of large streams.

Gravel-plain placers. Placers found in the gravels of the coastal or other lowland plains.

Sea-beach placers. Placers reconcentrated from the coastal-plain gravels by the waves along the seashore.

Ancient beach placers. Deposits found on the coastal plain along a line of elevated benches.

Lake-bed placers. Placers accumulated in the beds of present or ancient lakes that were generally formed by landslides or glacial damming.

Creek placers have usually been the most productive of rich gravel. The best values are generally found on and near bedrock and in depressions, cracks and crevices in the bedrock. It is therefore often necessary to take up a portion of the bedrock in order to recover the gold accumulated in the crevices.

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[1] Jackson, Chas. F., and Knaebel, John B., "Small-scale Placer Mining Methods," U. S. Bureau of Mines Information Circular 6611, 1932.

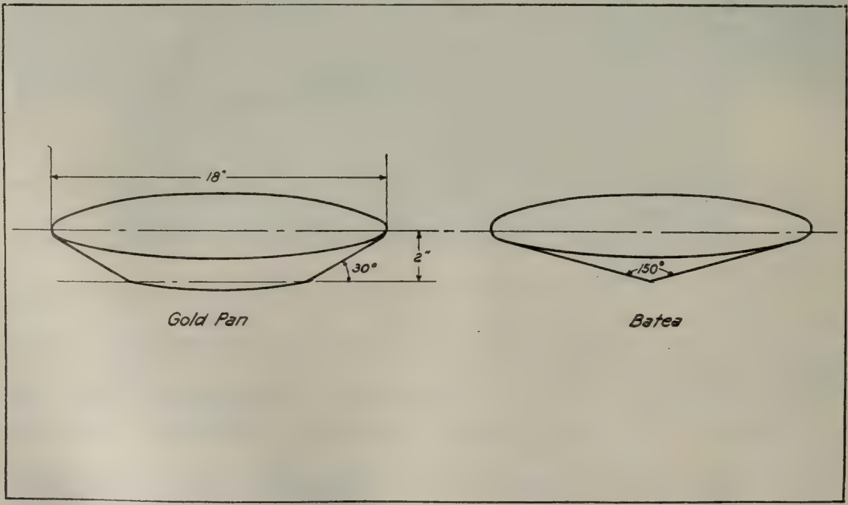
SIMPLE PLACER MINING EQUIPMENT

Perhaps the lightest equipment of all, consists of a tin can, cup, or small bottle and a pair of tweezers. With these the 'crevicer' during times of low water, picks the grains and flakes of gold from the cracks and crevices in schistose and slaty bedrock where it is crossed by stream courses, and saves it. Heavier equipment includes various-shaped gouges and bars, scrapers, scoops, and the much pictured pick and shovel. Whisk-brooms and wire brushes are used to aid in gathering the finer material into the gold pan for cleaning. Another primitive class of mining is known as moss-mining or 'mossing.' The moss growing on the rocks in some streams catches and holds appreciable amounts of fine gold. This moss is gathered and the gold shaken out, or it is burned and the ashes either panned, or winnowed; as grain was winnowed from the chaff by the wind, in biblical times. 'Winnowing' is also practiced to some extent in the dry desert areas.

The amateur gold prospector should always carry the indispensable gold pan, a cheap magnifying glass and a magnet, or knife with magnetized blade. The total cost of such mining equipment where a rocker, dip box or short sluice only is to be used, need not exceed $10.

THE PAN, ROCKER DIP BOX AND SLUICE BOX[1]

The equipment and operations described herein are among the simplest, and have been used in California to recover gold from placers since the days of '49. They are not only used for gold, but any heavy materials may be separated from lighter ones in this way. They are adaptable for the separation of cassiterite (stream tin), tungsten ore, cinnabar, platinum metals, gem stones, etc.



Gold-Pan and Batea.

The *gold-pan* is used in prospecting for gold, in cleaning gold-bearing concentrates, and in the hand-working of very rich deposits. It is a shallow pan which varies from 15 inches to 18 inches in diameter, at the top, and from 2 inches to 2½ inches in depth, with the sides having about a 30° slope. It weighs from 2 to 3 pounds. They are usually made of a heavy-gauge steel with the rim turned back over a heavy wire to stiffen it. Where amalgamating is to be done in the pan, they are either made of copper or have a copper bottom. When used by a skilled operator, it has a capacity of from half a yard to one yard in ten hours.

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[1] Contributed by Henry H. Symons, Junior Mining Engineer.

The object of panning is to concentrate the heavier materials by washing away the lighter. To do this most efficiently, all material should be of as even a size as possible. The pan is filled about three-quarters full of gravel to be washed, then it is submerged in water. First the large gravel is picked out by hand, then the clay is broken up, after which the operator raises the pan to the edge of the water, inclining it slightly away from him, moving it with a circular motion combined with a slight jerk, thus stirring up the mud and light sand and allowing it to float off.

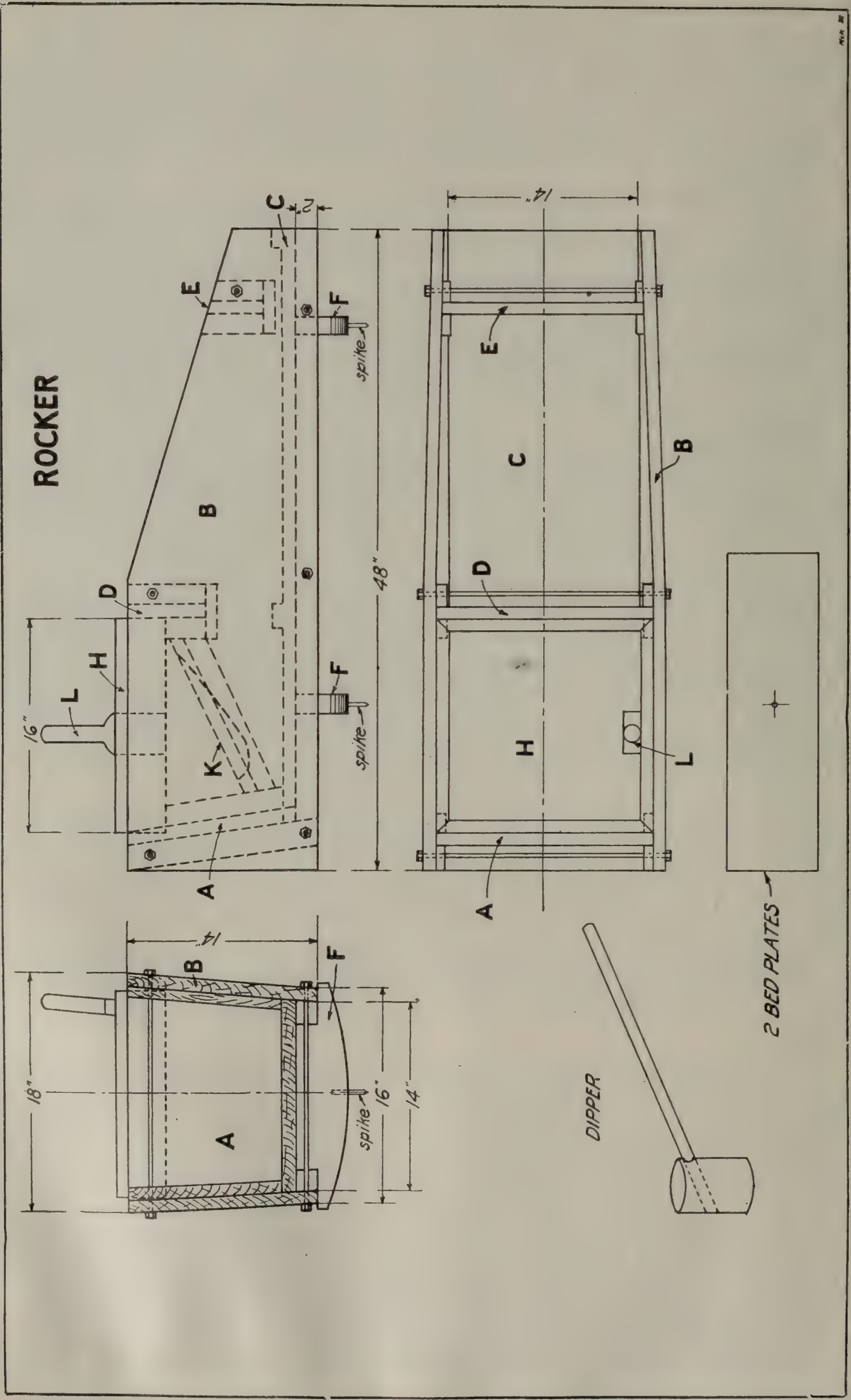
This is continued until only the heavier materials remain such as the gold, black sand and other minerals having a high specific gravity. These concentrates are saved until a large quantity accumulates, after which the gold is separated from them. It may be picked out by hand, amalgamated with quicksilver, sometimes in a copper-bottomed pan, or in some cases where the separation is extremely difficult and the quality and quantity justifies they are shipped to a smelter. Panning may be best learned by watching an old-timer or experienced operator at work, learning certain tricks in the trade from him. A clean six or eight-inch frying pan makes an excellent prospecting or clean-up pan. It is well to burn out an iron pan after having used quicksilver in it, and then polish it with a soft rock or piece of brick, otherwise it may be impossible to see small colors or flakes of gold.

The *batea* is cone-shaped and is the equivalent of the pan. It is made of wood or sheet metal. They vary from 15 to 24 inches in diameter and have an angle from 150° to 155° at the apex. It is claimed by many that wood will hold fine gold better than metal. The batea is in common use in Mexico, Central and South America, and Asia.

A shallow wooden chopping bowl may be utilized as a substitute for the batea. This would be used in the same manner as a pan.

Rocker.

The rocker is a machine to save gold from auriferous sands and gravels by concentration (sometimes in conjunction with amalgamation). They vary greatly in size, shape and general construction, (locality), the design considered best by the builder (experience and depending on material available, whether the gold is coarse or fine ease of construction). There are several gold-saving devices manually and mechanically operated described in a succeeding section that are in reality forms of the rocker modified to suit conditions. This is well shown as it is easy to find rockers that vary in length from 24 to 60 inches or more, with widths varying from 12 to 24 inches, and height 6 to 24 inches. Some have a single apron, and others two aprons and screens with holes to ½-inch diameter. There will be found an even greater variety of devices to stop the values, riffles of all kinds, blanket,


ROCKER
B
C
2"
E
F
spike
D
H
L
16"
K
F
spike
48"
A
14"
E
C
B
D
H
L
A
14"
B
F
18"
A
spike
16"
14"
DIPPER
2 BED PLATES

carpet, rubber mat, cocoa mat, canvas, cowhide, burlap, amalgamated copper plate, etc. The writer would suggest as a fairly efficient and easy construction of riffles for a rocker, to clamp $\frac{3}{8}$-inch metal lath over a double thickness of blanket so that it can be easily removed for cleaning. Of all wet placer methods for saving gold, the rocker is one of the most economical on water for the amount of material handled. The average rocker when operated by two men has a capacity of about 3 to 5 yards in ten hours, using 100 to 800 gallons of water.

Construction. Rockers are built in three distinct parts, consisting of a body or sluice box, a screen and an apron. The floor of the body holds the riffles in which the gold is caught. The screen catches the coarser materials and is a place where clay can be broken up to free it of all small particles of gold. The apron is to carry all material to the head of the rocker, and being made of canvas stretched loosely over a frame, has a pocket or low place on which coarse gold and black sands can be collected.

The accompanying drawing gives a suggestion for a knocked-down rocker that can be built by any one. The material required to construct it is given in the following tabulation:

A End, one piece 1″ x 14″, 16″ long
B Sides, two pieces 1″ x 14″, 48″ long
C Bottom, one piece 1″ x 14″, 44″ long
D Middle spreader, one piece 1″ x 6″, 16″ long
E End spreader, one piece 1″ x 4″, 15″ long
F Rockers, two pieces 2″ x 5″, 17″ long
H Screen, about 16″ square outside dimensions with screen bottom. Four pieces of 1″ x 4″, 15$\frac{1}{4}$″ long and one piece of screen 16″ square with $\frac{1}{4}$″ or $\frac{1}{2}$″ openings or sheet metal perforated with similar sized openings.
K Apron, made of 1″ x 2″ strips covered loosely with canvas.
For cleats and apron, etc., 27 feet of 1″ x 2″ is needed. Six pieces of $\frac{3}{8}$″ iron rod 19″ long threaded 2″ on each end and fitted with nuts and washers.
L The handle, in the drawing is placed on the screen, although some miners prefer it on the body. When on the screen, it helps in lifting the screen from the body.

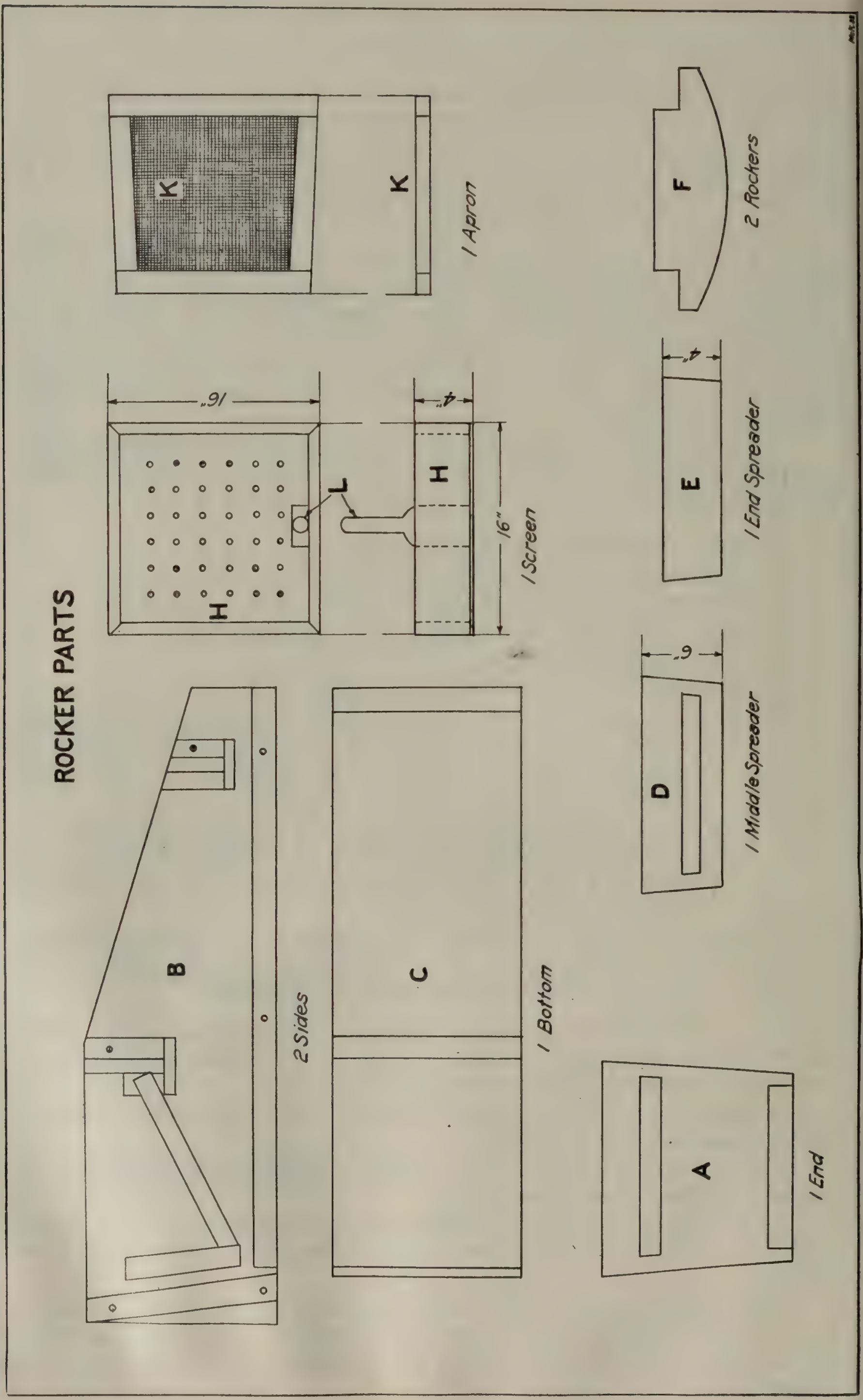
If 1″ x 14″ boards can not be obtained, clear flooring tightly fitted will serve, in which case about 12 feet of 1″ x 2″ cleats in addition to that above mentioned will be needed.

A dipper made of a tomato can (2$\frac{1}{2}$″ can) and thirty inches of broom handle is also necessary.

Through the center of each of the rockers a spike is placed to prevent slipping when in operation.

In constructing riffles, it is advisable to build them in such a way that they may be easily removed, so that clean-ups can be made more readily.

Two planks about 2″ x 8″ x 24″ long with a hole in the center to hold the spike in the rockers are also required. These are used as a bed for the rockers to work on and to adjust the slope of the bed of the rocker.


ROCKER PARTS
B
2 Sides
C
1 Bottom
A
1 End
H
16"
4"
L
16"
H
1 Screen
D
6"
1 Middle Spreader
E
4"
1 End Spreader
K
K
1 Apron
F
2 Rockers

Operation. When the ground to be worked has been found, the miner picks a place near by his source of water for his rocker. The first thing to do here is to set the bed plates so that the spikes in the rocker fit in the hole in the plate and so that the floor has the proper slope. This slope is decided according to the ground to be worked. Where most of the gold is coarse and there is no clay, the head bed-plate should be 2 inches to 4 inches higher than the tail bed-plate; where most of the gold is fine or clay is present or a combination of both. this slope is lessened sometimes to only an inch. It is hard to save very fine gold or where very muddy water is used, as the operation does not let the fine values settle out but rather floats them off.

After the rocker is placed in position. the screen box is filled with gravel, which is washed off by pouring water over this material with the dipper. The larger gravel, when clean. is either picked out with a fork or by hand and all clay is broken up into a mud. Next the machine is rocked vigorously for several minutes. continually adding water. If all material that will pass through the screen has done so, the box is dumped and this operation is repeated until it is thought necessary to clean the apron. The apron should be cleaned several times a shift. as all coarse values are caught there. These concentrates are placed in a pile for further cleaning. The riffles are cleaned whenever it is thought necessary. but not nearly as frequently as the apron, and the concentrates are saved for further cleaning. When a blanket is used, it should be washed out carefully in a tub of water, as here a good per cent of the fine gold is found. All concentrates are cleaned further in a pan. It is important to use the right amount of water. The use of too much water will carry the material through this machine too quickly, and with it many values. And where not enough water is used, it makes a mud which will not let the fine gold settle.

The Dip Box.

This is a modification of the sluice box and may be used where water is scarce and there is not enough grade for an ordinary sluice. It is portable and may be carried in an automobile. It will permit handling about as much dirt in a day as a rocker, though the larger stones will have to be thrown out by hand.

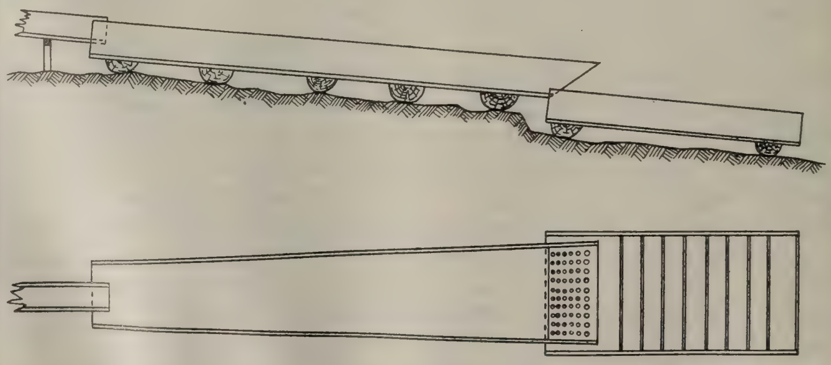
The dip box is simply a short sluice with a bottom of one inch by twelve inch lumber to which are nailed sides of three-fourth inch or one inch by six inches. The back end-piece may also be of one inch by six inch stuff and the lower end-piece one inch or one and one-half inch high. To catch the gold, the bottom of the box may be covered with burlap, canvas or thin carpet. Over this, beginning one foot below the back end of the box, may be laid a strip of heavy wire screen of one-fourth inch mesh (made from No. 13 or No. 14 wire) one foot wide by three feet long. Burlap and screen may be held in place by cleats along the sides of the box. The dip box may be made six to eight feet long. Those who use it often claim that practically all the gold will be saved in the first three feet. The box is given a steep grade by being set on small trestles, the one near the head end being about waist high and six inches to a foot higher than the lower one, near discharge end. The dip box is used by dumping the sand and gravel, a small bucketful at a time, into the back end of box, then pouring water from a dipper, bucket or hose onto it until it is washed through the box, discharging over the lower end. The gold will lodge mostly in the screen. Riffles may be put in the lower part of the box to stop gold passing the screen. Water should not be poured too violently into the box. The larger stones must be thrown out by hand, unless the box is fitted with a hopper, or a screen.

Puddling Box.

Where muddy or clayey material is to be sluiced, the first box of the string can be made into a ''puddling box.'' This can be three feet wide by six feet long, or any convenient dimensions, with 6-inch or 8-inch sides, and no riffles. The clayey material can be shoveled into this box and broken up with a hoe or rake before it passes into the main sluice. Lumps of clay in a sluice may pick up and carry away the gold particles.

Long Tom.

A long tom is an inclined trough used to concentrate auriferous earths and gravels. They have a greater capacity than a rocker, but also use more water in preparation, because the water is the carrying agent of the finer materials. They are mostly of crude construction, being built in two sections, as shown in the accompanying drawing: the sluice box, and the riffle box. Their slope is generally one inch to each foot in length, but this is varied as conditions warrant. The sluice box is usually about twelve feet long and about 15 to 24 inches wide at the head or upper end, and 24 to 36 inches wide at the tail or lower end, with sides about 8 inches high at the tail. There is a screen or piece of perforated sheet metal to prevent the coarse material from



LONG TOM

going to the riffle box, and at the head end there is a flume or iron pipe from which the water is fed. The riffle box is usually shorter than the sluice box, and slightly wider than the latter at the tail end. It begins just below the first opening in the screen, sometimes has a more gentle slope. Here the riffles are placed to catch the values, the box often being lined with canvas and as in the rocker, it is best to build detachable riffles. The sluice box should be made of 2″ lumber to withstand the abrasion of the gravel.

The capacity of a long tom is from 4 to 6 yards in a 10-hour day, per man, two to four men working.

Operation. The ground to be worked is shoveled into the sluice box and washed by the water coming from the head end. One of the men will work the material in the trough with a fork, taking the coarser gravel out when washed clean and keeping the screen from clogging. Clean-ups are made when necessary, usually at the end of the day, but experience might show that they should be made oftener.

Sluicing.

Sluicing is a method of working auriferous gravels in a flume called a sluice box, or in a ditch, called ground sluicing.

The sluice box is a crude sloping flume or trough, having riffles on the bottom to catch the values. Their dimensions vary greatly and are governed by the amount of material to be washed through them. The slope varies from 5 to 18 inches in a twelve-foot length. The riffles also vary, sometimes there are several kinds in a single sluice, some of which are quite elaborate and require considerable work in laying.

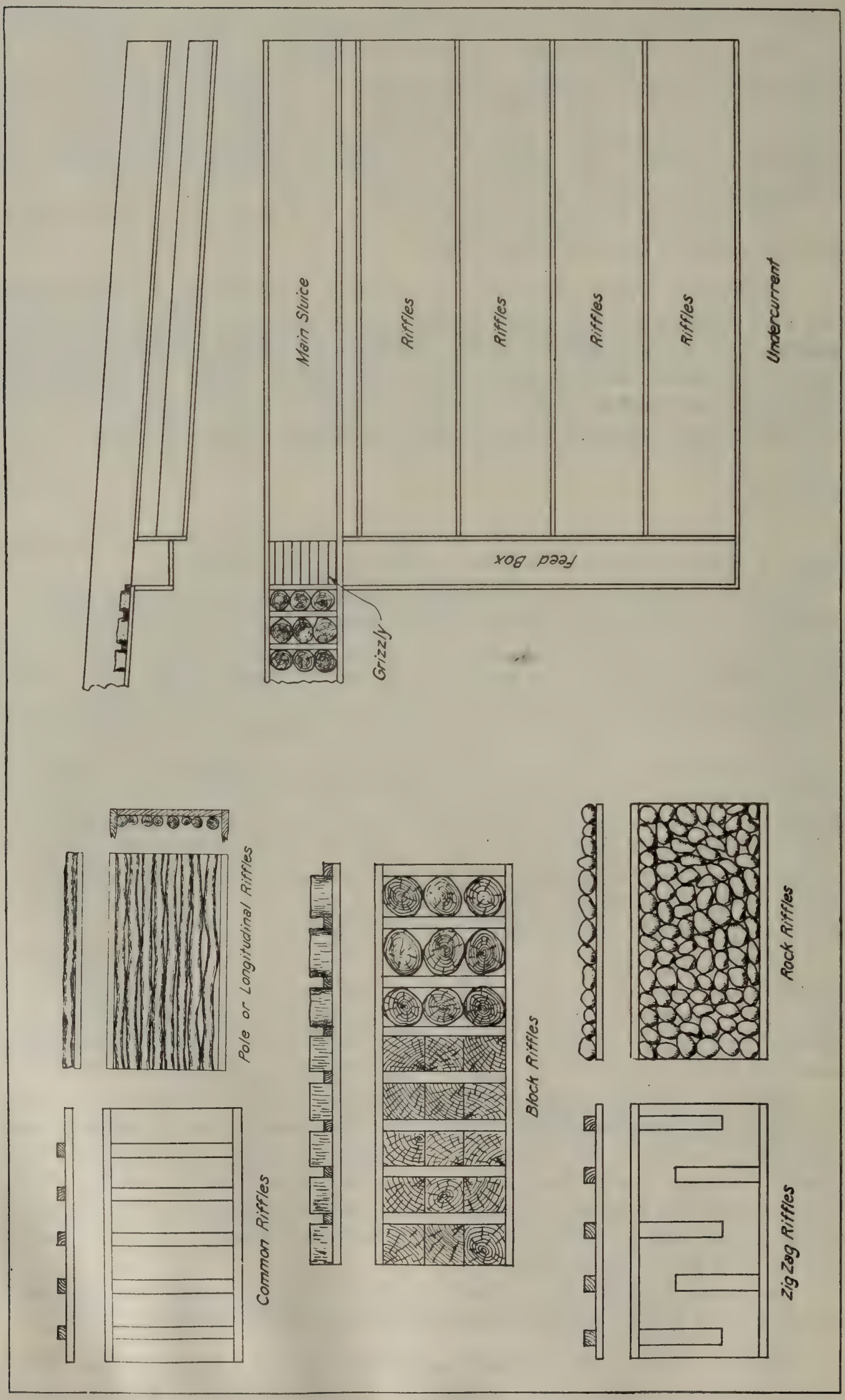
In the rocker and long tom, all the coarse materials are removed, but in the sluice all is allowed to pass through, or in some cases a grizzly is placed at the head of the sluice box to catch the very coarsest of material; but allowing much heavier gravel to enter than in the other devices previously described. This coarse material serves to grind and polish the gold, thereby cleaning it and making it easier to amalgamate, and possibly freeing some material mechanically held.

In sluicing, much of the manual labor done in the preceding methods is eliminated, as the water does all of the carrying of the material. In some cases the mining is done by hydraulicking or a stream of water is allowed to fall over a bank and in that way wash the material to the sluice.

Sluicing requires more water than the other methods previously described, the amount depending upon the material to be washed, and varying from 20 to 80 cubic feet of water to move one cubic foot of gravel. Coarse gravel requires more water than fine, but as the grade is increased the amount of water required is lessened. The capacity of the sluice box is governed by its grade and amount of water available as well as its dimensions.

In ground sluicing a ditch is dug along bed-rock and natural irregularities in the bottom furnish pockets which catch the gold.

Riffles. Riffles are obstacles placed along the bottom of a sluice which form pockets to catch values, by concentrating the heavier materials. There are numerous forms of riffles with innumerable modifi-


Main Sluice
Riffles
Riffles
Riffles
Riffles
Undercurrent
Feed Box
Grizzly
Pole or Longitudinal Riffles
Common Riffles
Block Riffles
Rock Riffles
ZigZag Riffles

cations of which some of the best known are described in the following paragraphs:

Common riffles or slat riffles are strips of wood or iron extending across the sluice box. The abrasion is so great that replacement is required often and therefore other types of riffles are preferred in large scale operations.

Pole riffles are frequently used and are 2 to 4-inch peeled poles placed either across or lengthwise of the sluice box. This type is used with coarse material and is efficient in concentrating both coarse and fine values.

Block riffles are made by paving the floor of the sluice box with wood blocks cut across the grain, and 4 inches or more high depending on the depth and width of the sluice, in rows, nailed to slats which extend across the sluice. These may be made of either square or round blocks. This method is good for both coarse and fine materials.

Rock or stone riffles are made by paving the floor of the sluice with rock, either stream pebbles or flat stones quarried for the purpose. They are held in place by strips of wood being nailed across the bottom at intervals. This method is good for both fine and coarse material, and extra good for cemented gravel.

Zig-zag riffles are slats placed part way across the floor of the sluice box alternately from the sides. This type is good for fine material and concentrates in a similar way to panning.

An undercurrent is a wide flat sluice placed beneath the main sluice box and used for the purposes of saving the fine gold. They are usually 5 to 20 times as wide as the main sluice and from 10 to 50 feet long. They receive their feed from a grizzley or screen placed in the floor of the main sluice box from which the fine material drops into a trough which distributes the feed evenly across their whole width. Undercurrents usually have a greater incline than the main sluice.

SPECIAL MACHINES AND PROCESSES

In the early working of virgin placers, it was possible to recover a large proportion of the gold by simple appliances and without great effort or expert knowledge. All the methods used were based on the fact that gold has a higher specific gravity than most other metals or minerals, which causes it to resist the action of moving water, while the lighter materials are readily acted upon and thus separated from the precious metal.

Methods and appliances have changed as the richer deposits have been worked out and the recovery of payable quantities of gold become more and more difficult. From the beginning of placer mining to the present time these methods include the use of the miner's pan or batea, the rocker or cradle, the long tom, the ground sluice, the riffle box or sluice, booming, hydraulicking, dredging, beach-sand work, dry washing, mechanical handling, and drift mining. In all of these methods actual mining and recovery are combined more or less closely into a single operation.

Some placer deposits contain only heavy gold; in others the gold is in a very finely-divided state or accompanied by large amounts of heavy black sand; or the deposit may be situated in a region where there is little or no water available for working. To meet these various conditions numerous schemes have been proposed and new devices developed to increase the efficiency of recovery.

The inventors of fine or 'flour' gold and platinum machines, 'black sand' machines and other gold-saving devices are legion in number. There are said to be more than 7000 of them patented. Some of these schemes are little more than ideas, others have been developed to a point where they may be shown on paper. Some have been built and tried out with some success under certain conditions, and a few machines or appliances have proved their worth, are being manufactured on a commercial scale and have been adopted as valuable additions to the technology of placer gold mining.

In the January, 1929, quarterly chapter of State Mineralogist Report XXV, the writer described 64 of these special processes and machines. A flood of inquiries came to the Division of Mines regarding them from all parts of the United States and from South America, Canada, Australia and other countries. In the April, 1932, chapter of State Mineralogist Report XXVIII, 117 were described. The interest aroused resulted in numerous other machines coming to the attention of the Division of Mines and over 200 are now on record.

A considerable number have passed out of the picture, but it is thought that the ingenuity shown in developing these processes will be of interest even to the layman and that the gathering together and publication of information regarding them will possibly be of some value to many owners of placer deposits.

In no instance has any machine, device or process herein described been tested or approved by the Division of Mines, although some of them have been observed in operation by representatives of the division.

Their merits and demerits or suitability for any given conditions must be determined by those directly interested.

The data given have been obtained in most cases from the owners or manufacturers of the machines or proponents of processes, from advertising matter, and from users, or it has been gathered from various published articles and the Division of Mines can not assume responsibility for any claims or statements made.

A list of the names and addresses pertaining to all of these machines and processes will be supplied upon request accompanied by 10 cents to cover cost.

Acme Gold Recovery Unit. The new and improved Acme Unit is so efficient, small, light and compact that it can be taken anywhere; it works wet or dry.

"With the Acme Unit you do not need mercury or 'quick', as the separating solution frees and separates the fine gold from the black sands, cleans the 'rusty' or corroded gold, then you recover the coarse and fine gold right in the finishing pan. You can work in stream or in tubs or tank, using the water over and over without sliming, if you use the separating solution. You can work it dry, it being better and more efficient than any drywasher.

"The Acme unit consists of the Hispeed Mechanical Concentrating pan with hydraulic pressure pipe, hopper and automatic agitating feeder grill; this also helps to pulverize and force-feed all the material over the cup; with this newly invented feature, all values must get over the gold cup, this makes positive gravity separation; the unit also includes the new-type hand-finishing pan, the sampling pan, special magnet, and panning secrets with complete instructions for operating the panning outfit, prospecting, etc.

"Besides being a complete gold recovery unit in itself, it is the best cleanup outfit for handling and cleaning up concentrates from sluice boxes, dry washers, rockers, jigs, tables, etc.

"The new model is simple and easy to work—stand erect, let the pan turn on the foot-bearing, do not carry any weight or make hard work of it. Set the pan in position, fill the hopper and half-turn the handle with both hands, back and forth, just fast enough to make the dirt 'move and slide' in the pan; the agitating grill makes it feed automatically down into the pan, over the gold cup, the material being in motion, the heavy stuff naturally goes to the bottom of the cup; keep right on shoveling dirt into the hopper and panning; the waste dirt will start flowing over the outer edge of the pan; after panning an hour or two, give the pan a whirl, or lean it over to one side and get the remaining waste material out, then empty the cupfull of black sand and gold or concentrates into the finishing pan; you can do this all day and make a final cleanup each night or every few days, depending on how rich the ground runs in values."

Acosta Placer Mining Machine. This contrivance consists of a sluice box and a concentrator together with a gasoline engine, a barrel of water and hydraulic vibrator mounted on one side of the concentrator, which makes of this concentrator virtually a self-shaking gold pan.

"Each unit of the machinery has a new feature except the gasoline engine which is of 20-h.p. capacity, although only 8 pounds of water pressure is needed to operate the vibrator. Therefore the engine and pump may be run at idling speed with a minimum of heat and wear. The barrel of water is used over and over again in operating the machinery.

"The sluice box has new features incorporated in its construction. About 12 feet long, it leads from a box in which rollers break up the coarse lumps sending it into a specially divided hopper at the upper end of the sluice box from where it is shaken downward along the box by the constant shaking of the concentrator upon which is mounted the lower end of the sluice box. There are seven screen-opening 'riffles' at regular intervals along the 12-foot length of box, each permitting coarse gold to filter through into a small metal trough under the box and leading to the concentrator. Some of the fine gold particles will stick in the wood openings and there be reclaimed while others will accompany the coarse into the concentrator. The coarse rock particles roll on over the screens into a pile beyond the concentrator after the gold is shaken out.

"The concentrator is unique in that it is mounted on four coil spring shock absorbers retrieved from the rear of old model T Ford cars, and is shaken by an ingenuous device invented by Mr. Acosta and mounted on one corner of the widened hopper which is the top of the concentrator box and made of metal.

"This vibrator is a metal cylinder made from a vacuum tank used on cars a few years ago before force feed was adopted generally in carburation. Water pumped from the barrel goes through this vibrator at any designated speed, operating a diaphragm which causes the entire concentrator to vibrate, thus shaking the finer particles of gold dust and sifting it out of the coarser rock particles over a fine screen.

> "The two grades of gold are handled differently, the coarser grade being shaken into one channel and the finer going below where it drops into a bottle of mercury below the box and is thus concentrated, while the coarser is emptied through a side opening into another container."

So far as known the Acosta machine has not been placed on the market.

Ainlay Centrifugal Gold Separator. The Ainlay Centrifugal Gold Separator saves fine flake and 'rusty' gold, with a very high per cent of recovery, in most cases, being 95% or better. It works equally well on coarse gold, platinum and amalgam.

> "The principle of the Ainlay machine is simple and positive. The separation is made in a revolving bowl mounted under a revolving screen equipped with sufficient power to also operate a centrifugal pump furnishing water for the operation.
>
> "Material is fed through a hopper into the revolving screen, permitting that portion of the charge to screen into the bowl. A small quantity of water is fed into the screen through a perforated pipe, washing the charge thoroughly and passing into the bowl with the fine material. Centrifugal force holds the values securely in the riffles but permits the wasted material to pass over the top of the bowl. The clean up is easily made through a plug valve in the bottom of the bowl.
>
> "The Ainlay machine completely does away with the 'black sand' problem. Can clean up in five minutes at any time—which is a tremendous advantage in testing ground. No mercury, electric current or chemicals are used. Cheap to operate. One gallon of gas will run the 12-inch machine six to eight hours.
>
> "Slow speed and best workmanship insure long life, with few adjustments. Especially adapted to arid regions, as it requires but 15 gallons of water per minute and the water can be used over and over again. Muddy water does not affect the recovery in the least. It is also adapted for use in milling free gold ores.
>
> "Anyone can operate it from the printed instructions. It is foolproof. Capacity of 12-inch machine, two or three cubic yards per hour bank run, depending upon character of gravel.
>
> "The 12-inch machine complete with gasoline engine, screen, pump, etc., weighs 800 lbs.; mounted on a trailer to be attached to an auto or wagon, 870 lbs.

	Capacity per hour in yards	*Water used per minute*	*Power*	*Weight*	*Price*
"Model A	2 to 3	15 gals.	3 h.p.	800 lbs.	$700 00
Trailer				70 lbs.	50 00
"Model C	10 to 20	55 gals.	11½ h.p.	2,000 lbs.	935 00

> Delivered at railroad station in California or Nevada.
> Capacity given refers to bank run."

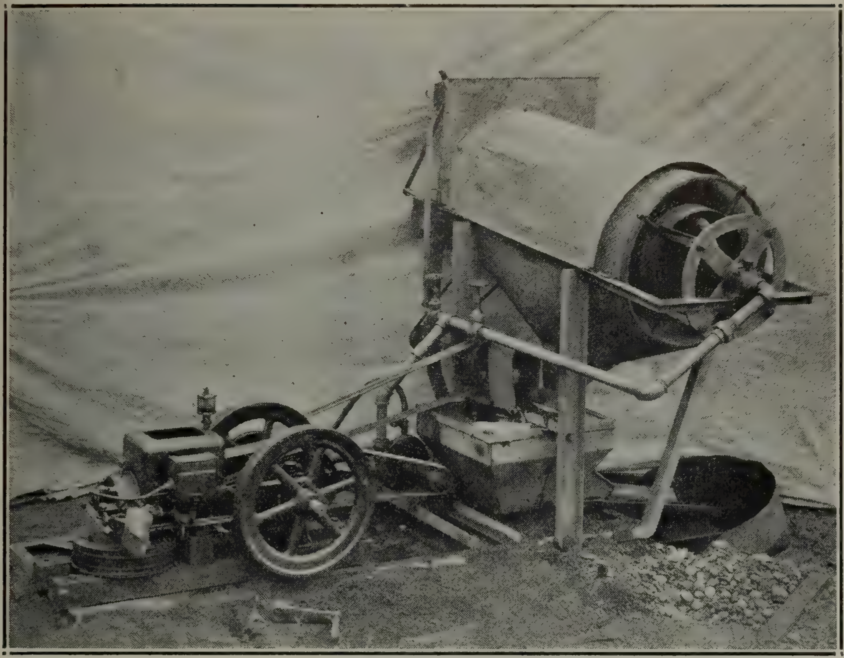
The Ainlay machine is manufactured in small and large units. It has been extensively used. A further description is contained in The Mining Journal, Phoenix, Ariz., October 15, 1932.

All Steel Placer Dredge and Undercurrent Sluice Box. Portable placer mining equipment made in Los Angeles. Details regarding this equipment will have to be obtained from manufacturer.

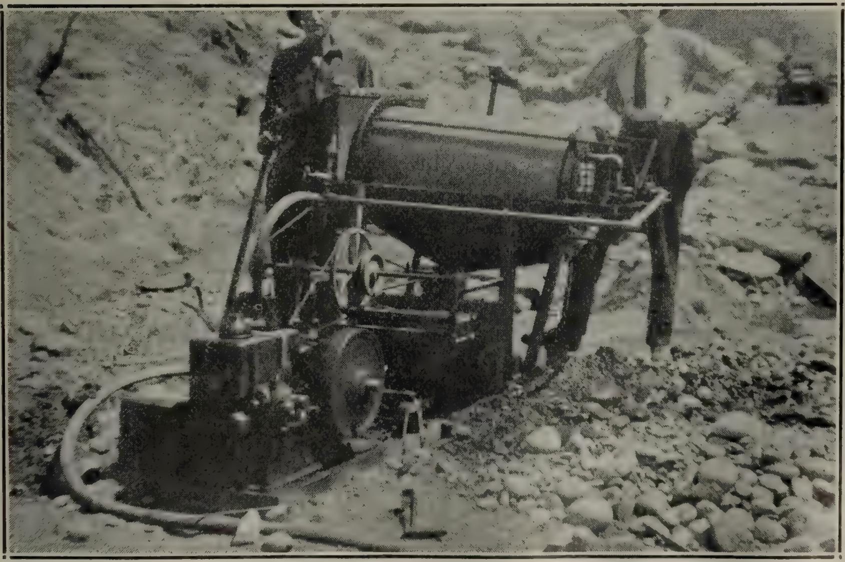
Amalgold (Tar Process). A plastic composition which catches and holds gold and platinum brought in contact with it.

Argonaut Rocker. An all-metal rocker maufactured by an old established company. One item of a complete line of placer and quartz mine and mill machinery made by this company.

Australian Dry Blowers and Jiggers. Various types of dry blowers have been extensively used in the placer gold fields of Australia. These machines are hand operated and in most cases are mounted on wheelbarrow frames so they may be readily moved about. The *Buhre Dry Blower, Carlson Dry Blower* and *Rankine Dry Blower* are illustrated and their construction described, together with that of dry-jiggers in the Engineering and Mining Journal, October 11, 1902, to which those interested are referred for details.



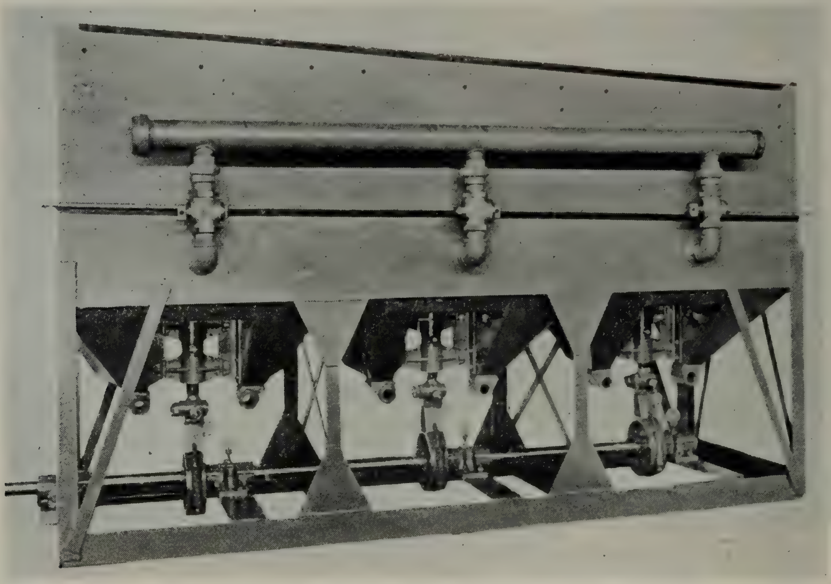
Ainlay Centrifugal Gold Separator, Model A.



Ainlay Machine ready for operation.

Bendelari Diaphragm Jig. The jig shown in cut is a 42-inch, 3-cell placer type, weight 6100 lbs., capacity up to 25 yards of $\frac{3}{8}$-inch material per hour; 5 h.p. required.

These jigs have been installed in place of long, riffled launders on the dredges of Bulolo Dredging Co., Ltd., in New Guinea.[1]



Bendelari Diaphragm Jig.

Beach Sand Concentrator. One of the simplest types of machine used on beach sands consists of a plain duckboard riffle fastened to a plank bottom, which is set out near the edge of the sea as the tide is coming in, and is kept constantly in such a position that the outgoing waves will wash the gold-bearing black sands over it. This machine has been used near Crescent City, and has paid day wages to the men operating it.[2] It is held down with rocks to prevent floating. An illustration of one of these surf washers and instructions for building it, by G. E. Elffner, is given in the Mining and Scientific Press, June 6, 1903, page 364.

Bennett Air Gold Saver. The inventor of this machine spent a number of years as a prospector and field scout for mining corporations in Lower California, Mexico, and other waterless regions containing dry placer gold deposits. He was later engaged in the construction of large pipe organs. Combining his knowledge of the use and handling of air in pipe-organ work with his realization of the usefulnes of a dry placer machine for such districts, he developed the Bennett air gold saver. This machine is said to differ from most dry washers in that it uses a pressure box, the vibrating air column being under pressure, the action of the machine somewhat resembling that of a jig. On account of the suspension of the material by the air pressure during its travel through the machine there is practically no wear on the special cloth under the riffles.

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[1] Mining and Metallurgy, February, 1934, p. 98; Engineering and Mining Journal, March, 1934, p. 129.

[2] Haley, Chas. S., Gold Placers of California. California State Mining Bureau. Bull. No. 92, 1923.

It is stated that damp as well as absolutely dry gravel can be sucessfully treated and 85% recovery of all gold obtained. The practicability of the Bennett air gold saver has been demonstrated at Quartz Mountain, Nevada, and near Oatman, Arizona, where dry placers have been worked successfully. The complete machine weighs about 375 pounds.

The Berdan Pan. This is not a new device. It has been long known and has been described in Engineering and Mining Journal[1] several times, but still there are probably many mine operators who are not familiar with it.

It is a valuable adjunct to a mill in cleaning up but is also useful in treating black sands for the recovery of fine gold, due to its grinding action and scouring effect on 'rusty' gold.

The standard size of Berdan pan is about 5 feet in diameter. The pan consists of a circular trough mounted on a steel driving shaft set at an angle in a frame and driven by gearing at a speed of from 10 to 15 revolutions per minute. A large ball travels in the circular trough as it revolves. The material to be treated is fed in continuously by automatic feeder or at intervals by hand, and a stream of water enters with the feed and continuously overflows from the lowest point on the lip, carrying off the tailing. The fineness to which the material is ground can be regulated within certain limits by the amount of water admitted.

The ball, which weighs about 120 pounds, rolls in a pool of mercury so that any free gold or 'rusty' gold that has been brightened by the grinding action will be immediately brought into contact with the quicksilver and amalgamated. The speed is so slow and action so quiet that practically no quicksilver is floured.

A small clean-up pan of the Berdan type (see cut) with 24″ cast iron bowl and ball 8″ in diameter is now on the market. A change, considered an improvement by some operators, consists in using a drag suspended so as to hang in the edge of the quicksilver pool instead of the ball which rolls in the mercury.

The actual grinding capacity of the pan is small, but it is well adapted for treating small lots of black sand, concentrates, or finely-ground free-gold ore. The power required is negligible.

Berger Gravel Washing and Gold Saving Machine.[2] This is a large mobile machine usually referred to as a dry-land dredge. Forty-three tons of structural steel carrying about twenty-one tons of operating equipment comprise the unit.

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[1] Engineering and Mining Journal, New York, Vol. 106, No. 25, Dec. 21, 1918, and Vol. 125, No. 19, May 12, 1928.

[2] Illustrated and described in detail in The Mining Journal, Phoenix, Ariz., December 15, 1932.

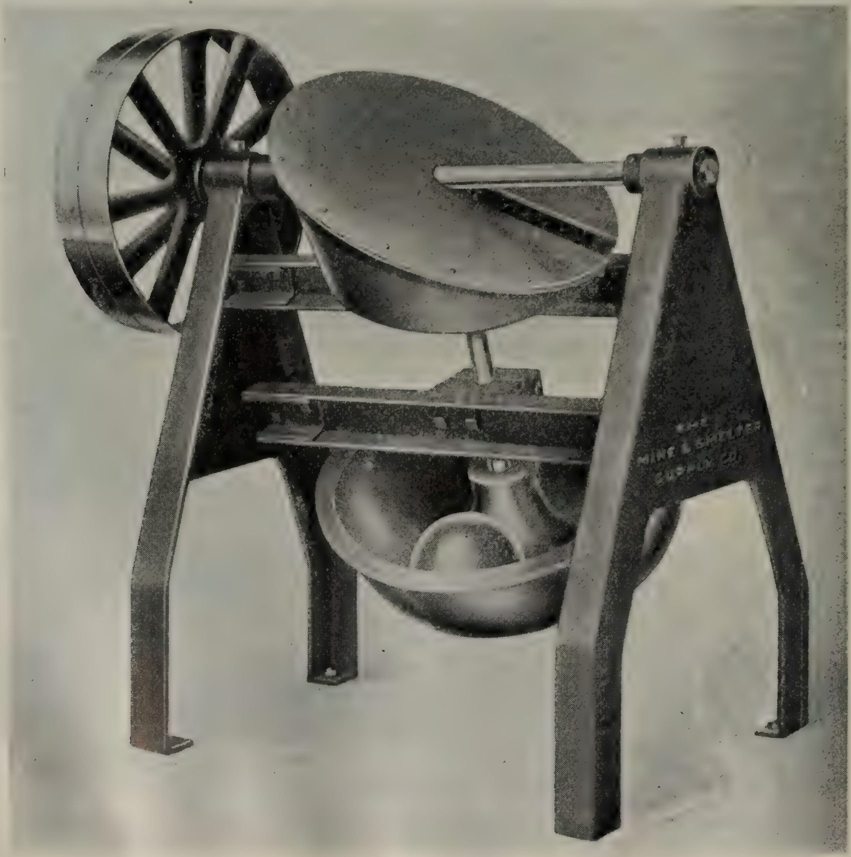
Black Gold Concentrator. The essential feature of the Black Gold Concentrator is a revolving drum with bottle-neck extension openings at each end through which the gravel enters and leaves the cylinder. The machine is designed to be permanently mounted on a truck and to be driven by a power take-off attached to the drive shaft of the automobile.

"The drum is made of heavy boiler plate. The bottle-neck extensions are firmly attached to it and rest on four steel rollers mounted on a rigid steel frame. The steel frame is fastened to the rear of the truck chassis by means of a hinge so located as to be exactly under the longitudinal center of the drum. A circular gear surrounds the drum and meshes with a small gear on the drive shaft of the truck. This small gear is movable on the shaft and may be disengaged from the drum gear when it is desired to move the truck.

"When the concentrator is to be operated it is placed so that the bottom of the cylinder slopes toward the discharge end on a gradient of about one foot in 10. Water is fed with the ore into the hopper at the feed end and remains at a constant level filling the drum about one-fourth full. The gold and heavy sands gravitate to the bottom of the cylinder and gradually work toward the discharge end where they are trapped by the obstruction formed by the end plate of the drum. Meanwhile the water and lighter waste matter is continuously discharging from the small opening.

"During clean-ups an eccentric lever which holds the drum in operating position is released and the cylinder is tilted to a highly inclined position, thus facilitating the removal by hand of the concentrates.

"The machines are made in two sizes. The smaller machine is 3 feet in diameter and 12 feet long, and has a rated capacity of one cubic yard per minute using water from a two-inch pipe under 25 pounds pressure, while the larger plant has a rated capacity of five cubic yards per minute, is 6 feet in diameter and 16 feet long, and uses a four-inch stream of water under 25 pounds pressure."



Small Berdan Pan.

Black Sand Treatment Process. Stated to be a process for recovering gold from black sand without concentration. No jigs, sluices or whirling devices are used. This simple equipment will be installed under royalty agreement.

Bonanza Dry Gold Concentrator. The Bonanza Dry Gold Concentrator is especially designed for use with placer and quartz ores where water is not available.

This machine is scientifically built with many features giving flexibility and adjustments to adapt itself to any character of ore. It is self contained, weighs only 700 pounds, and is mechanically smooth in its operation. It is built for a capacity of 25 to 35 tons in 24 hours and takes but 1½ h.p. to operate.

The cost of operation and maintenance is claimed by the manufacturers to be very low and the extraction which can be made very high. It is a simple, compact unit and "all you have to do is to grind your ore to the proper fineness, attach your motor or gas engine unit and save your gold."

Bonanza Matting. The primary use for Bonanza matting is in sluice boxes underneath the various types of riffles. It is a rough rubber-like material but is not a sponge rubber and therefore long-lasting and most easily cleaned. The material is made in but one size, sheets 2′ wide by 10′ long, but can be purchased in sheets 1′ wide by 10′ long. In either case, the price is 45 cents per square foot, parcel post-paid. While on the market only since the summer of 1933, the manufacturers claim a wide distribution, which gives ample evidence of its successful use.

Bowl-Type Gold Saver. In development stage. Financial aid to manufacture it is wanted.

Bray Straight-Line Placer Machine.[1] Another large mobile dry-land dredge with a capacity of 2000 yards a day.

California Dry Ore Concentrator Company. This company advertises that it has the only dry ore concentrator that is dust proof and fool proof and recovers 95% of values. First cost very low, operating cost more economical than any other. Requires small space. Installations from five tons daily upward. Further particulars may be obtained from the company.

No mention is made of placer operations and it is not known whether the machine is intended to work dry placers or not. It may be a magnetic concentrator.

Cedar Rapids Placer Machine. A mobile digging, screening and washing plant on the order of a dry-land dredge equipped with centrifugal bowls for recovery of gold and operated with caterpillar power.

Centrifugal National Concentrator, apparently is designed primarily to handle low-grade complex ores as a circular describing it makes no mention of its use on gold-bearing sands or placer material. The machine is said to be automatic and continuous in operation employing centrifugal force, doing with solids that which centrifugal cream separators accomplish with liquids. It is claimed that this concentrator will save and separate values of microscopic fineness not amenable to recovery by present methods of concentration and that it requires no chemicals or other outside agencies except water in its operation. A unit treating 200 tons of ore per day of 24 hours will occupy 100 square feet of floor space; may be operated by one man per shift and will consume less than 5 horsepower.

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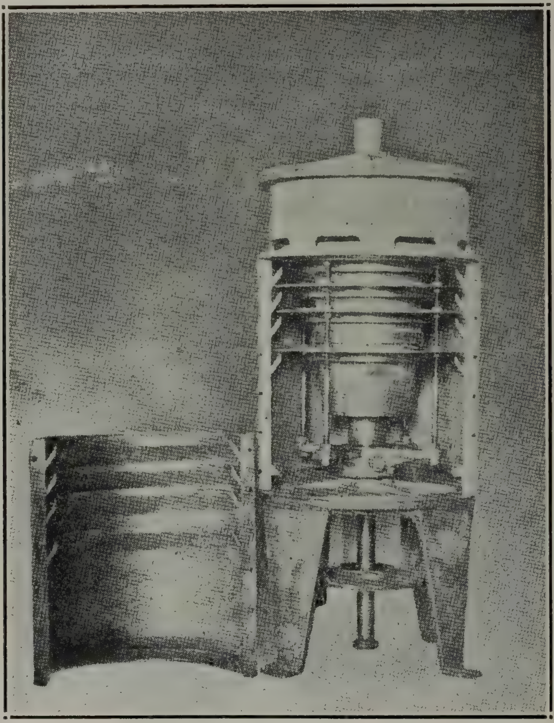
[1] Illustrated and described in detail in The Mining Journal, Phoenix, Ariz., July 30, 1933.

Centriplus Machine. This machine is described as an improved centrifugal concentrator with continuous discharge. A separator with a continuous concentrate discharge using centrifugal force to increase the specific gravity of metals or nonmetallic matter, so they can be extracted from the pulp or sands.



Centriplus Machine.

"It is composed of three major parts: The bowl (or stratifier); the spider (that which carries the rings); the housing (forming the body of the machine) carries the bearings on which the bowl and spider revolves, and the stationary launders, which catch the concentrates discharged from the rings.

"The bowl is circular in form with a larger diameter at the top than at the bottom, being about 23 inches high, 14 inches wide at the top, and 11 inches wide at the bottom. There are 4 or more slots cut in its side encircling it at different distances from top to bottom.

"The spider carries the rings, one of which is opposite each slot, in the bowl. They revolve with the bowl, but are independent of the bowl. The concentrates coming through the slots in the bowl are held by the ring. The ring is about 1 inch thick, with one wall vertical and one of greater radius with a discharge angle. The bowl is adjustable up and down in the spider, so that the slot in the side of the bowl (or stratifier) is on one or the other wall of the ring and so controls the discharge of concentrates through the side of machine.

"The pulp is fed into the bottom of bowl, or stratifier, where it is thrown against the inner wall by the centrifugal force. As it travels up the wall (owing to its angle) the heavier particles working to the line of greatest motion will be found next to the wall and as they travel up the side they are caught in the slots where they are held until discharged by the ring.

"The concentrates from each ring can be caught separate, as the heavier metals are discharged from the lower rings and a classified concentrate is obtained. The residue, after extraction of the concentrates, travels up and over the top of the bowl as tailings.

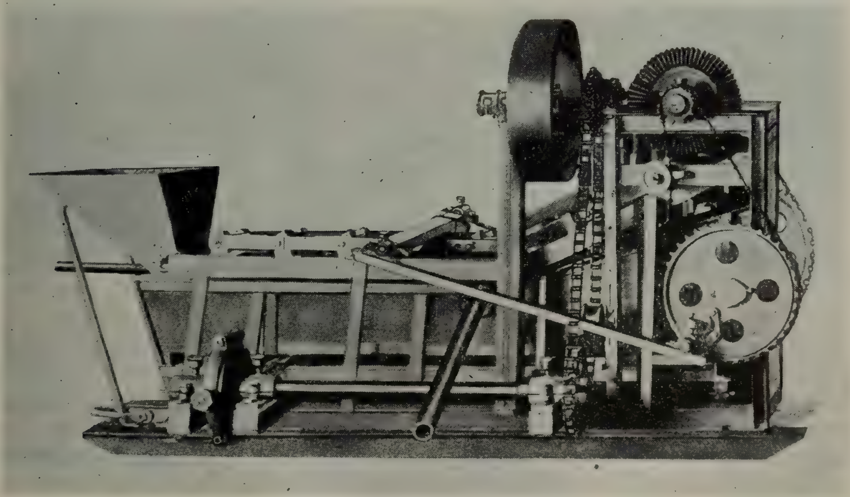
"A separator of this size will occupy a floor space 4 feet square. It will handle 50 to 60 tons per 24-hour run, from the finest of slime to heavy sands. There is no pulp too fine nor sands too heavy for this machine.

"As the water is used only to move pulp through the machine, its chemical contents have no effect on separation.

"It takes less than 2 horsepower to operate a separator of this size."

Champion Self-Cleaning Riffle. These are rubber riffles of special shape set in the sluice box at an angle. Their lower ends terminate in a tube which passes through the side of the sluice box and constantly delivers the black sand and gold into a parallel trough from which they are collected, therefore these riffles never become filled or choked with black sand.

Clark Agitating Sluice. Capacity 5 cubic yards per hour. Has been used in Colorado, Arizona and California on a commercial scale.

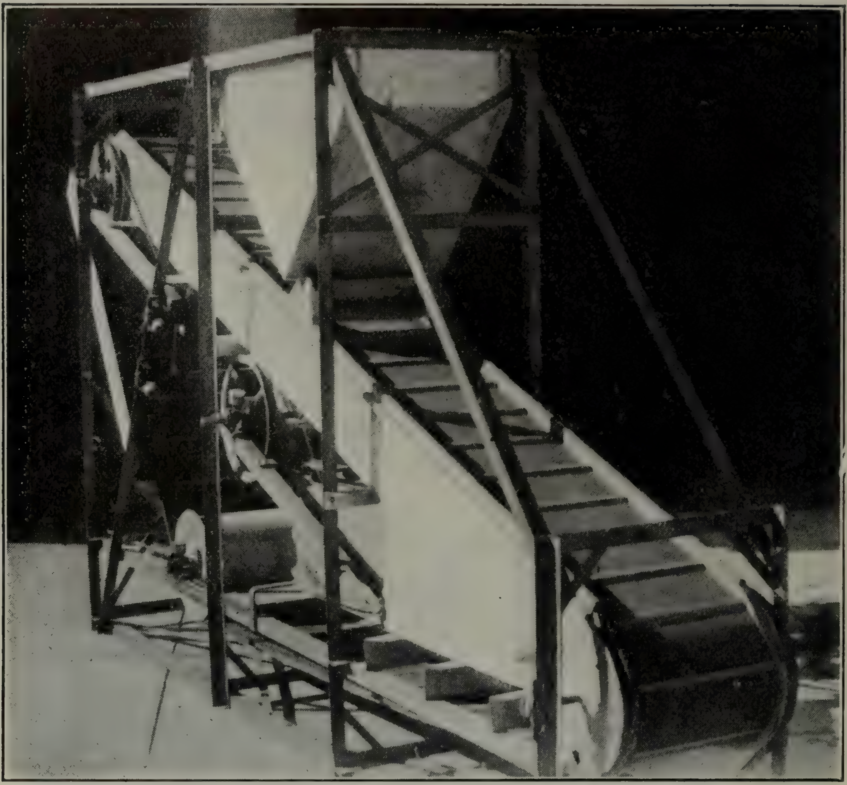


Clark Agitating Sluice Concentrator.

Cole Dry Separator. According to the manufacturers, their latest machine is designed for both ore or placer, and has a capacity of approximately three yards per hour of placer, or four tons per hour of ore.

"The machine is so designed that almost any richness of concentrate can be obtained by slowing down the moving belt. The tailings are discharged from the lower end of the machine while the concentrates are deposited from the head of the machine into a container. It is possible to concentrate as high as sixty to one with this new unit. When the material to be concentrated leaves the hopper it passes down over a moving belt which carries the concentrated material up to the top of the machine; when this material passes under the point of feed the concentrating action is still in full force which in turn throws any gangue over the riffles and leaves the materials as clean as possible; the gangue then travels down the moving board and meets the heads where it is reconcentrated. This action is repeated as long as the heads are passing over the riffle board.

"From tests on some ores extractions as high as 89% have been made. This was done on free-milling ore, by grinding it to minus forty mesh: and with placer, where the gold is free, practically everything can be saved, meaning over 97%."



Cole Dry Separator.

Commonwealth Dry Milling and Concentrating Process. This process is designed for the dry working of old dumps or ores. A plant may be stationary or portable for easy moving from dump to dump. The mill breaks the ore by a compression twist grind releasing the mineral from the matrix for dry concentration. The mill discharges 5 tons per hour of dry pulp which is automatically fed to 3 pneumatic jig tables, recovering 90% of the mineral.

It is estimated milling and concentrating will cost around 30 cents a ton and the capacity of the portable outfit will be about 100 tons per day. The Commonwealth mill can also be operated wet.

Continuous Flow Amalgamation Process. Simple processes have been successfully used only for the recovery of gold occurring in a free state in ores, placer sands and reefs, containing no other minerals or elements which cause excessive fouling of the mercury containers or sickening of the mercury itself, such as sulphur, copper, manganese dioxide, galena, and the sulphides of antimony, arsenic, etc. In very many cases of amalgamation of the free gold so much time is lost and expense is incurred that it becomes commercially unprofitable.

"With the development and advent of the International Machine to which a continuous amalgamation process can be automatically applied, recovery of gold can now be effected completely and rapidly from ores wherein it occurs in free state and from sands, regardless of the presence of injurious minerals or elements which might eventually foul the plates or containers to prevent satisfactory and profitable recovery of the values.

"In this process a tempered and enlivened mercury amalgam is fed continuously into a receptacle at the same time that finely pulverized wet ore is allowed to flow through and over it. This International process for continuous flow amalgamation consists in applying to mechanics, devised and recorded by Everson, a special tempered mercury, through and over which can be run a constant flow of concentrates containing gold, platinum and other precious values, for amalgamation. The mercury immediately from the tempering treatment is conducted through a separate tube of copper to the center of a wide-rimmed saucer-shaped rotating receptacle of specially tempered and chemically treated electrolytic Lake Superior cold rolled copper, which is spun to fit snugly a base-bow of bakelite or other electrical nonconductor. The flow of prepared concentrates for separation is also fed in at the center of the saucer-bowl and below the central mercury level.

"Centrifugal force by rotation of the bowl brings the amalgam from the supplied center, as it absorbs its load of values, up the incline of the saucer's rim to its outer edge and over the rim of the bowl, at which is a recovery trap which catches and retains the loaded amalgam directing it to the filter locked within the cast iron base of the machine. After the mercury is filtered from its load it is again retreated or tempered and forced again to the bowl. The flow of extracted concentrates passes through, out of and above the mercury over the edge of the bowl, and trap, into a waste launder. Power which rotates the bowl drives the mercury filter pump and electric generator. Thus the machine becomes simple, compact and entirely effective on a large flow of concentrates accommodating a plant as high as 1000 yards a day.

"A reduction of black sand (concentrate) values by a special mill to a colloidal common denominator before entering the separation process will give with this machine approximately a 100% recovery. Gold in colloidal suspension carries an electrical charge. A direct current from a special generator through the suspension and the mercury, over the saucer-bowl, driving the gold by repulsion constantly into the mercury, as well as adding materially to the amalgamating temper of the mercury, adds most effectively to this process.

"At intervals the filters should be removed through the locked iron doors and new filters inserted. Pack the amalgam contents of the filters into retorts and recover any mercury by distillation. Heat the final contents to burn out the filter fibre and other impurities which may be subject to combustion and take the residue (gold) to the mint for refining further.

"The flow both of gold-bearing concentrates (black sands) in suspension with water and also the newly tempered mercury, should be uniform and constant for the best results.

"Success of the process is due not only to the novel and exact mechanical principles involved but more particularly to the correct knowledge of tempering or treating the mercury to a constituency of being able to amalgamate not only fine and flour gold but even the gold in colloidal suspensions which may be in the flow of concentrates.

"Greater success also is due perhaps to the special treatment of the cold rolled copper saucer-bowl, which tends to cling tenaciously to the active amalgam within it and makes the rim trap for separating the amalgam from the concentrate gangue possible."

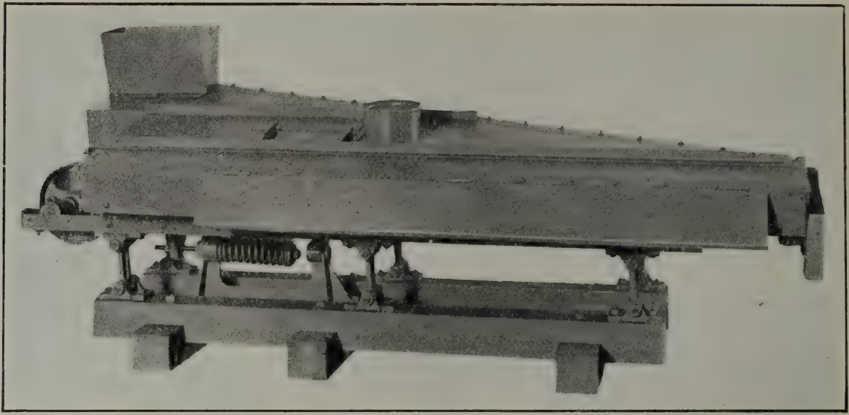
Cottrell Pneumatic Portable Dry Washer. This machine is designed solely for dry placer operations and can be easily handled by one man. Fitted with screen and elevator and mounted on skids it makes a light portable unit.

It is manufactured in all sizes with a capacity of from 1 to 25 yards per hour.

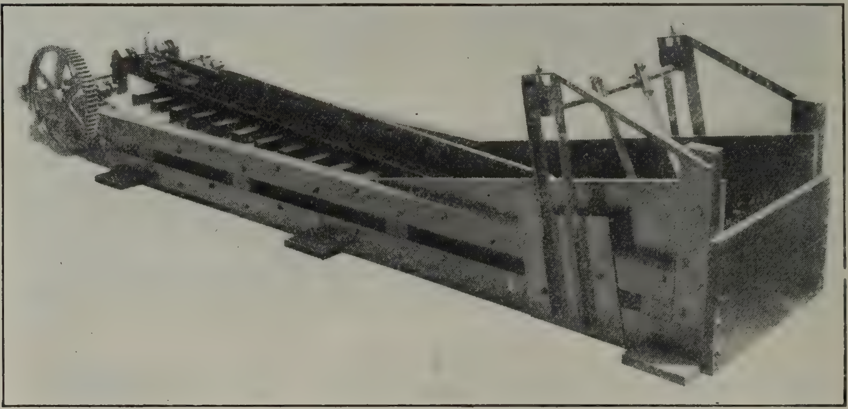
The manufacturer states that although of the simplest type yet it is built to withstand the strain to which a machine of this kind is subjected, the best materials being used and all parts made accessible. The riffle board is of perforated corrugated steel and is removable for cleaning purposes.

Air is supplied by a constant blower and the machine is given a side motion by means of an eccentric. The air pressure is regulated by a valve and the angle of the riffle board may be adjusted to suit requirements. A screen and cover can also be fitted and the machine may be obtained complete with engine, blower, screen and elevator, or as a separate unit.

This company also manufactures a pneumatic dry concentrator for the concentration of various metallic ores, and in the nonmetallic field for the separation of crystalline silica from pumice, ash and sulphur from coal, etc.



Cottrell Dry Concentrator.



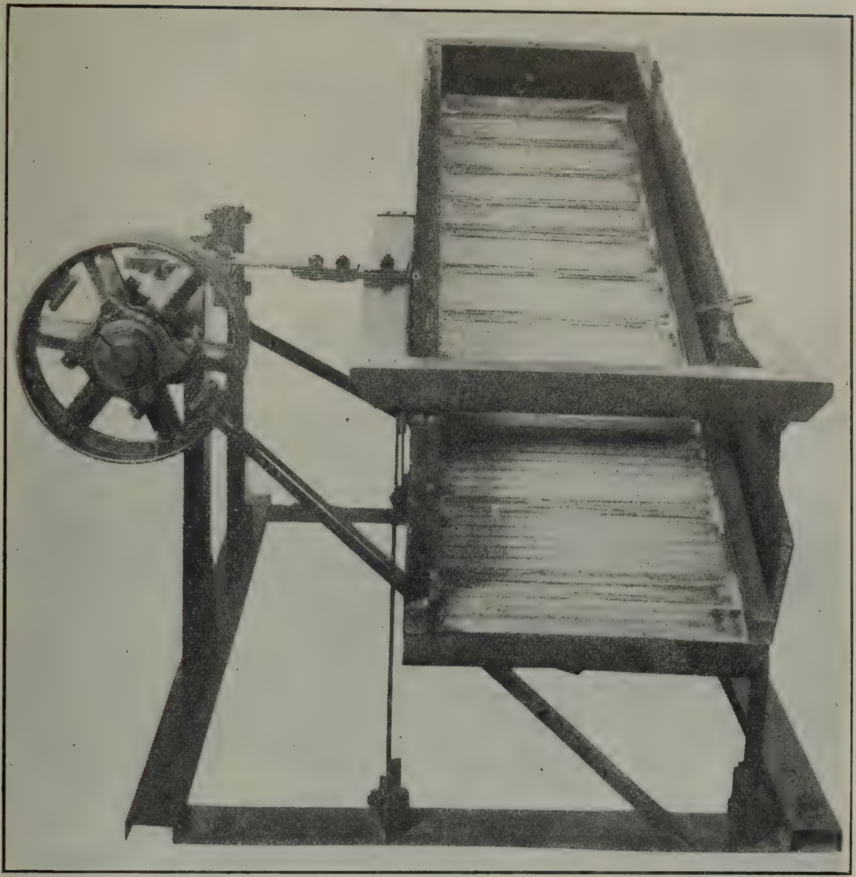
Cottrell Wet Placer Machine.

Wet Machine: The same company manufactures a simple wet machine in which an undershot flow of water cases flotation, the gangue is removed by a mechanical system of rakes and the gold settles down into a specially prepared compartment. A capacity of approximately 50 tons per hour may be handled by the standard 12-foot machine.

Crangle Hydraulic Pulsating Placer Jig. This machine has been built and demonstrated in the laboratory and field.

Crear Black Sand Machine. No description of this machine is at hand but the builder invites inquiries.

Crown Placer Concentrator. Described as a new economical placer mining dry-land dredge. It is claimed to handle yardage economically and save the values. Especially adapted to properties where there is a scarcity of water. Units from 24 cubic yards to 5000 cubic yards capacity per 24 hours.



Cottrell Dry Placer Washer.

A prospector's model is also made with a capacity of 1 cubic yard per hour, price complete, f.o.b. Seattle, $350.

Cunningham Process, for recovering gold and platinum in river placers. It is stated that in this mining scheme it is proposed to use the river bed itself as a natural sluice, the idea being to lay a series of pipes across the stream on bed rock. These pipes are slotted so that black sand, gold and platinum being carried along the river bottom by the natural current will work through the slots and collect in the pipe just as these minerals collect in natural crevices in the bed rock. Means are provided for removing the collected material from the pipes. Apparently once installed there would be little work connected with operations.

Denver Mechanical Gold Pan. The principle of this machine is simple, utilizing practically the same motion that has made the hand-pan famous. This motion is obtained by slightly tilting the pans, and a steel yoke and saddle connected to a rotating ball-bearing eccentric gives a positive vibrating motion which settles the gold. It is driven by a $\frac{3}{4}$-h.p. gasoline engine which also runs a pump to furnish the necessary water to wash the gravel.

"The vibrating motion thoroughly washes and screens the material over a coarse punched plate and then a finer screen; thus the oversize is screened out and the finer product falls on the first concentrating pan for recovering the values. Large gold nuggets are always visible on the screen surface.

"There are three concentrating pans, all 24" in diameter and below the feed hopper. The first, or No. 1 pan, has a copper bottom and amalgamates the gold, principally in the finer sizes. The vibrating motion makes the screened product come in close contact with the amalgam. From here the material flows by gravity to the No. 2 pan which is made of steel with special rubber matting in the bottom with 1-inch wire screen over it. This rubber matting saves the fine flake and coarse gold; due to the specific gravity, the gold stays in the recesses of the matting. The wire screen gives a swirling action which also aids with this natural recovery. The No. 3 pan is the same construction as the No. 2 pan, recovering the remaining gold or floured mercury.

"By this method the screened material (usually minus 10 mesh) is given 3 distinct treatments, using amalgamation and gold-saving matting, although the operator can use any type of gold-saving blanket, amalgam plate or device in any of the pans."

Denver Mechanical Gold Pan.

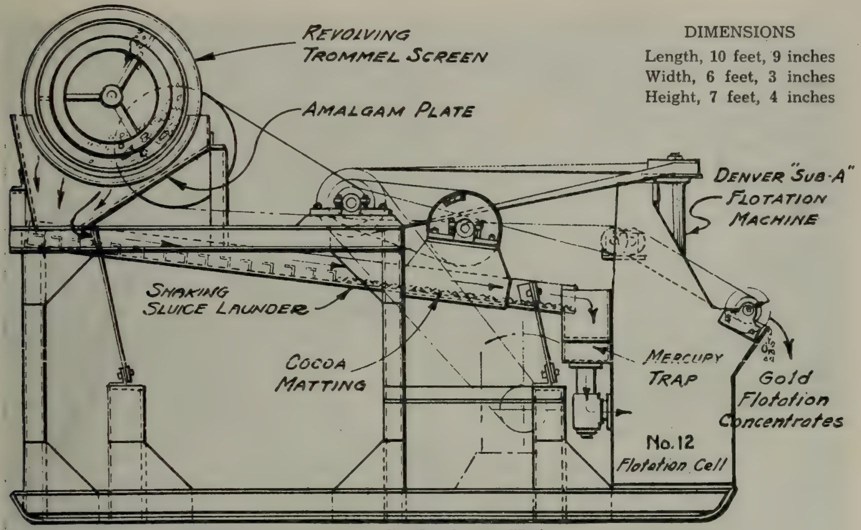
Denver Gold Placer Unit (with flotation cell).

"In the past it was comparatively easy to obtain coarse gold from placer deposits or free milling ores, but fine flour gold and gold contained in sulphides and tellurides was aways difficult and expensive to recover. Until now, fine grinding was necessary, but today the Denver "Sub-A" (Fahrenwald) Flotation Machine, with patented gravity flow principle handles material as coarse as $\frac{1}{4}$ inch without choking. The Denver "Sub-A" Unit will recover fine gold and also flour gold out of this coarse feed, at a good profit, without classification or grinding.

"The mineral-laden material is shoveled into the hopper, where coarse rock is washed and removed. The fine material goes to a screen with additional water, and the undersize product (usually about $\frac{1}{8}$ inch or 3 millimeters) passes into a shaking sluice box.

"This sluice box is removable and equipped with different types of riffles, cocoa matting and also amalgam plates to recover heavy gold. From the shaking sluice box or launder, the feed goes to a mercury trap for recovering mercury, amalgam and gold which may escape from the launder.

"Flotation recovers fine flour gold. From the mercury trap the feed passes direct to the gravity flow Denver 'Sub-A' flotation machine, where the fine gold and minerals which float naturally are recovered in the froth. This is the only practical way of recovering these values, even out of an oxidized ore. Heavy wearing parts make treatment of this comparatively coarse product mechanically possible. The various gold concentrates can be amalgamated so that gold bullion is sent to the mint.



DIMENSIONS
Length, 10 feet, 9 inches
Width, 6 feet, 3 inches
Height, 7 feet, 4 inches

Denver Gold Placer Unit.

"There is no complicated equipment and it is simple to run. The operator soon becomes experienced with the details of riffling and with the conditions giving best results in the flotation cell. The reagents used to float the gold are easy to handle, inexpensive and simple to regulate.

"Denver Gold Placer Units are of all-metal construction, completely self-contained and easily transported from one place to another. The power unit is separate, but transmission equipment is furnished. Electric motor, steam or gas engine can be mounted directly on the steel framework."

Dreifus Dry Concentrating Machine. The machine consists of a metal cylinder open at both ends. Welded inside of this is a spiral ribbon. The cylinder is 48″ long by 30″ in diameter and the spiral is $2\frac{3}{4}''$ wide at the lower end, tapering uniformly to zero at the upper end. The cylinder is set at an angle of about 15° from the horizontal. A $\frac{1}{4}$-h.p. gas engine will furnish sufficient power. It is operated at a speed of about 10 revolutions per minute and will handle 2 cubic yards per hour.

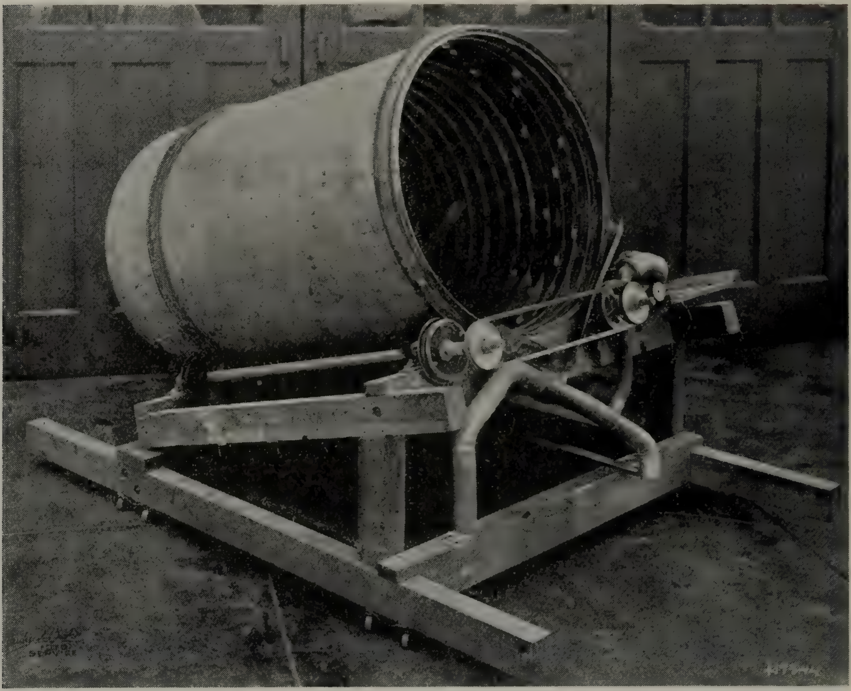
"The gold-bearing sand and gravel are fed into the lower end of the cylinder about one foot inside the end.

"The gold or other heavy mineral remains in the bottom of the spiral trough and is gradually carried up and out the upper end. Two baffles or strips of metal a foot long and 2″ wide, placed above the spiral helps to retard the lighter material as it passes over the spiral ribbon and out the lower end.

"As the gold and black sand drop out the upper end they fall into a trough connected with two tubes and so arranged that a blower of small intensity tends to blow most of the lighter black sand down one tube while the gold passes down the other. In a number of test runs made good recoveries have been shown."

Duplex Aireo-Vanners (Dry) concentrate placer gravel, mill sand and slimed values, or classify clay and nonmetallics. It is stated that production costs can be cut and recoveries increased by their use. Dust collectors protect workmen from all dust. Not made in toy sizes.

Economy Wet Placer Process Mills. A recovery system involving classification before concentration, with special screening, jig and table units. These complete placer mills are built in four sizes. Complete details may be obtained from the manufacturer.



Dreifus Dry Concentrating Machine.

Edison Dry Process, for separation of gold from gravel. It should be of interest to the inventors of gold-saving machines and they may feel complimented to know that the late Thomas A. Edison is numbered among them. About 1897 Edison took up the problem of finding a process which would save gold in a large placer deposit situated in the arid regions of New Mexico.

An account of his work and a cut of the Edison Dry Placer Machine, by Cloyd M. Chapman was published in the Engineering and Mining Journal, May 9, 1903.

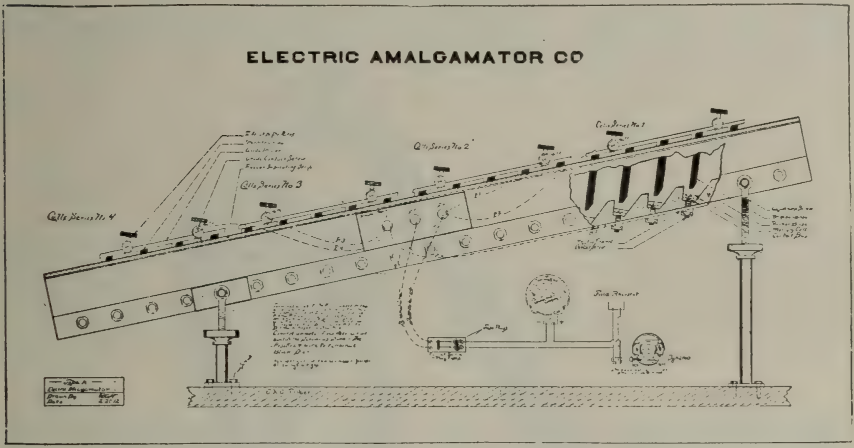
Electric Amalgamator Company manufactures a patented electric amalgamator which appears from a circular to be applicable mainly to milling practice as no mention is made of its adaptability to placer operations.

Electrolitic Process for Recovery of Gold. When brought to the attention of the Division of Mines in 1933 this process was in the development stage. Information regarding its present status will have to be obtained from the inventor.

Ellis Automatic Electro-Chemical Gravity Method.

"The Ellis Automatic Electro-Chemical Gravity Method for separating minerals from ore is the only actually continuous and automatic chemical process, for separating minerals from ore, in practical use, and the cost is only a few cents a ton more than the ordinary amalgamation process. The leaching is commenced in the mill battery and continued down a launder provided with riffles for aerating the pulp and solution. After passing through a launder of sufficient length, say 50 to 500 feet, the pulp and solution runs through an electric precipitator and amalgamator that precipitates the minerals in solution and forces the same by gravity in contact with amalgamated copper plates and riffles, amalgamates the precipitates and free gold and silver. The pulp and solution, after extracting the values, passes into dumping tailing tanks, where the coarse tailings are retained, with the solution running through a filter bottom and overflow into settling tanks, from where the solution, after filtering or settling, passes to a sump and is pumped back to the mill to be used over again. Two tailing tanks are used for the coarse tailings for each precipitator and are dumped alternately, one draining, while the other is filling, or they may be made to dump automatically.

"The idea of this process is not to dissolve the gold as much as possible, as with all other chemical processes, but to dissolve it as little as necessary, only enough to free it and clean it for good amalgamation, which is also assisted by the electric current in passing through the machine. The amalgamated copper plates in the machine are at all times kept in best possible condition for amalgamation by the solution of cyanide or other chemical combination used and the electric current by which the mineral in solution is precipitated. The precipitant being an electric current generated by electric batteries, not depending on the chemical action in the precipitator, the precipitation will continue regardless of the different minerals and bases in the ore as long as there is no insulating coating on the anode.



Electric Amalgamator Company's Apparatus.

In this process the cyanide will act more on the ore in a few seconds with the thorough aeration of pulp and solution in passing down the launder, being continuously checked and violently agitated by the riffles, than it would with hours of leaching in tanks. In the precipitator, the pulp and solution are forced in contact with the anodes and cathodes alternately by pressure of gravity, both being amalgamated copper plates and only a fraction of an inch from each other, thereby giving very intense electric action on a small amount of ore a short time, and forcing the precipitates and mineral in contact with the amalgamated surfaces.

"The leaching being only partial and with the weak solution not having time to act much on the bases, very little cyanide is used, as the electric current regenerates greatest portion of the small amount used. With this process taking the crushed ore direct from the mill, it ought to be cyanided at a cost of from 5 to 15 cents a ton exclusive of royalty. In working old tailings the cost of taking the pulp to the receiving hopper must be added."

Elsol Dry Concentrating System. Various types of dry concentrators and dry washers have been on the market for years and thousands of dollars have been expended on experimentation and development work in dry concentration, with the result that varying degrees of success have been attained.

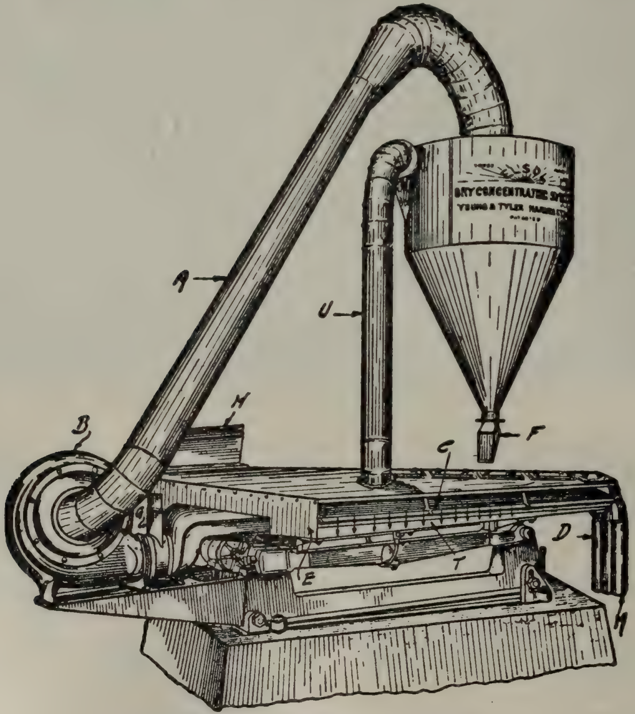
"The appearance of the 'Elsol' marks a new epoch in dry concentration since it combines the successful features resulting from years of experience, giving a machine having positive working qualities coupled with efficiency and simplicity. In other words, it gets both the fine and coarse values with little classification, and at the same time does so in the simplest possible way, with no complication, few wearing parts, low repair costs, and with a minimum expenditure of power.

"Quite often large percentages of fine values are lost, due to their being blown from the table by the air system. The 'Elsol System' allows nothing to escape except unreleased values going to tailings. By proper crushing this percentage of unreleased values may be reduced to a very small amount. The peculiar formation of the riffles of the 'Elsol' concentrator securely holds both fine and coarse values once they are caught therein. Any small amount of very fine values rising from the table are taken up by the air system and caught in the dust collector forming a part of the 'system.'

"In the 'Elsol System' the table movement is accomplished by means of a peculiarly arranged set of eccentrics which together with a relatively high rotation gives the rapid progressive movement of the material. There are no springs and no lost motion; the action is positive and requires a minimum of power.

"The riffles of the 'Elsol' concentrator are of an obtuse angled V-shape with one side—the front or bottom side—longer than the other, and when in its working position a cross-section presents an appearance similar to that of the lip of an ordinary gold pan when being used by an expert panner.

"At the upper or feed end of the table these riffles are of comparatively large cross-section and gradually taper down to a small cross-section at the concentrate-discharge end. The object of this is two-fold: It gives a greater longitudinal angle to the upper riffles, besides reducing the capacity per unit length of riffle as the discharge end is approached.



Elsol Dry Concentrating System.

"The greater longitudinal angle has the effect of holding the values more securely once they have been caught, since the riffle cuts more sharply across the line of travel of the tale movement. The reduction of cross-section has the positive effect of eliminating the gangue matter which may be riding near the top of the riffle.

"The bottom side of all riffles are perforated with a nozzle-like perforation placed at such angle as to not only give the lifting effect on the material (thus allowing the values having the higher specific gravity to settle to the bottom) but also to aid in a more rapid advance of the material along the riffles.

"Standard sizes, with average capacities:

	Capacity, tons per hour			
	Quartz	Placer	Power required	Weight
"No. 2	2–3	8–10	2 h.p.	1800 lbs
"No. 3	4–5	20–25	3 h.p.	2000 lbs.

"The concentrator is all metal. The riffle board is in one piece, corrugated and perforated by special dies. The high speed positive movement is set in dust proof ball bearings. These parts are mounted on a cast iron base, assuring perfect alignment under all conditions.

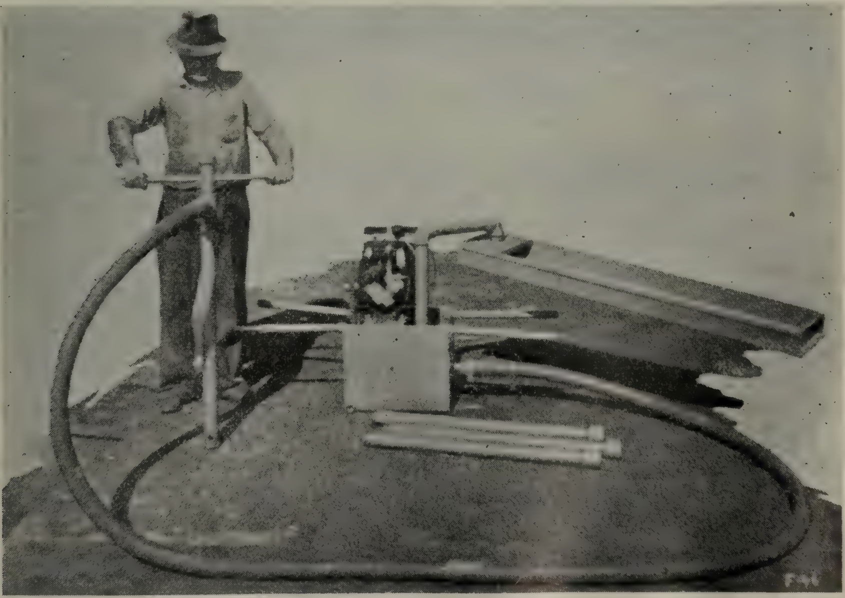
"The dust, one big objection to dry concentration, is no objection in the 'Elsol' for it automatically cares for its own dust by its self-contained dust system.

"No classification is necessary, the peculiar shape of the riffles automatically taking care of this feature.

"The operation of the Elsol Dry Concentrator is readily understood by referring to cut. A specially constructed single piece metal surface 'C' over which the crushed ore is made to travel, forms one of the principal features necessary for efficient concentration. This surface is formed by special dies into V-shaped corrugations or riffles tapering from a relatively larger cross-section at the feed end 'H' to small cross-section at the concentrate discharge end 'D.' One side, the front or bottom side of these corrugations, is perforated with tiny nozzle-like openings through which air is forced from air-chamber 'E' on which the surface is mounted. The air shooting through these tiny perforations together with a rapid table movement quickly causes stratification of the material. Once stratified, the progressive movement and reduction of cross-section of corrugations continually causes an elimination of the top strata of the material in each riffle until the discharge end is reached, where the gangue matter has practically all been eliminated. Whether the concentrate is fine or coarse, provided it is caught in the valley of the riffles, it can not escape, as the movement continually crowds the heavy particles into the valley, and no air comes in contact with the particles thus reaching the bottom. A certain proportion of very fine material, due to air and agitation, will rise from the table surface. This is drawn up through the uptake 'U' and collects and discharges at 'F.' The return air circuit 'A' connects with the exhauster-blower 'B,' which serves the double purpose of supplying air to the air chamber and collecting the fine simultaneously. A blastgate, plainly seen in the illustration, between the blower and air-chamber, properly regulates the air supply.

"These machines are operating in the field with a success heretofore unknown to dry concentration. The following ores have been treated with uniform success: lead-zinc, lead-silver, copper, tin, gold, iron, antimony (both oxide and sulphide), tungsten, wulfenite, chrome, manganese.

"While certain classes of ores respond to concentration in much the same way it must be remembered that the fundamental principles underlying any system of gravity concentration are based on a difference in specific gravity between the materials to be separated. Generally speaking, the greater this difference the more clearly defined becomes the line of stratification, the cleaner the concentrate and the more perfect saving. There are other conditions, however, that modify this statement to considerable extent, such as size, shape and density of the material to be separated. It is these 'other conditions' along with the fact that the same kinds of ores in different localities have different characteristics, that makes it difficult to predict just what savings can be made on a given ore, even though certain definite results have previously been obtained on the same kind of ore."



Essick Suction Dredge.

Essick Dry Placer Washer. A new type ball-bearing dry washer incorporating features not found in other outfits. It is compact, operated either by power or hand and sells at a very low cost.

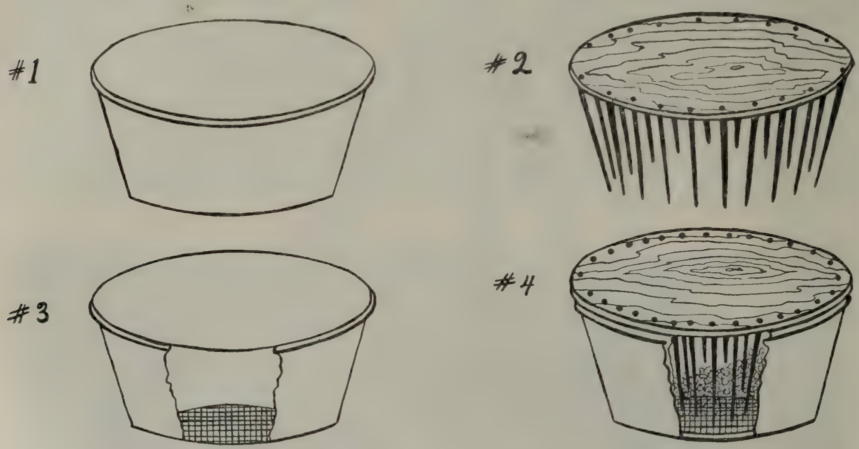
Essick Suction Dredge. This is a 2-man gold dredge operated by a 1-h.p. air-cooled engine. It is equipped with 20′ suction and 40′ pressure head. Capacity is 3 to 5 yds. per hour and 225 gallons of water per minute. Weight approximately 200 lbs.

Evans Gold Pan Combination.

"To operate, place screen No. 3 in pan No. 1. Fill with sand and gravel from 1" diameter to as fine as it comes. Press the spikes which are in lid No. 2 down into sand and gravel as far as they will go, then apply a quick oscillating motion from left to right for about 5 seconds; follow with a forward and backward motion for the same length of time. Repeat both motions alternately once more, then raise the screen and lid together about 1". Give one more little shake to expel any little particles or values which might still be on the inside of screen. Now dump the tailings. This operation can be repeated a dozen times before it is necessary to empty the concentrates.

"When operating with water, there should be enough water to completely cover all the material in the combination pan No. 4.

"This gold pan combination is designed to recover gold from sands and gravel (either wet or dry). It is claimed to have many times the capacity of old style gold pans, to weigh only a few pounds more and sells for a nominal price. U. S. patent application has been made, Serial No. 630,053."



Evans Gold Pan Combination.

Fabriform Amalgamator. After testing various amalgamation processes a special amalgamator by this name was reported recently installed at the Good Hope Mine, Riverside County, to rework the dump. One unit is expected to handle from 40 to 50 tons per day.

This machine,[1] said to be low in cost, simple to install and operate, is being used successfully at the present time by a number of concerns in southern California, Lower California, and in the Mother Lode district. One particular installation at the Good Hope Mine near Perris, is obtaining approximately 90% recovery from reworking the waste dump at the mine, it is reported. The machine has been particularly successful in the recovery of fine and floating gold.

"Steel fabricated, of welded construction throughout, the Fabriform machine utilizes alloy steel case hardened gears, and anti-friction fully enclosed bearings. The bowl and riffles are dynamically balanced. The total weight of the machine is

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[1] Described and illustrated in Mining and Metallurgy, New York, January, 1933.

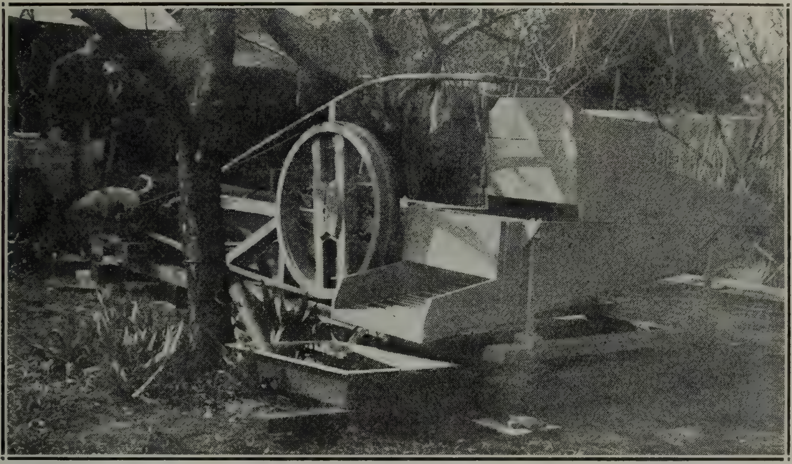
400 lbs. and it may be easily dismantled for transportation. Locking provisions are made for protecting the amalgam prior to cleaning up.

"Its operation is particularly simple. The principle is that of amalgamation through the application of centrifugal force. This forced amalgamation is controlled for various types of ores by adjusting the bowl speed.

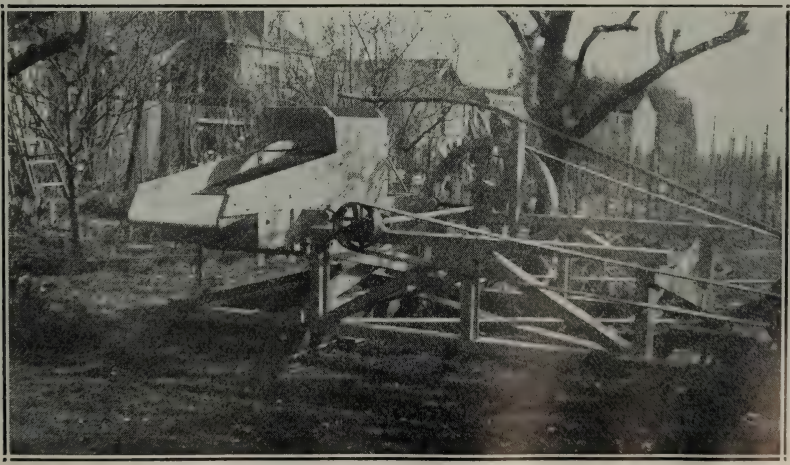
"The capacity of the machine itself is 40 tons at 40 mesh in 24 hr. The speed range for the amalgamator bowl is between 310 and 340 r.p.m. Approximately 35 gal. of water per minute is necessary for operation, regardless of the amount of ore going through the amalgamator.

"To prevent the mercury from flouring when striking the metal bottom, 2 or 3 in. of water in the bottom of the bowl are essential when the machine is started. There is no mercury lost in operation. Due to the vertical walls and riffles in the bowl, the mercury forms a vertical wall in the lower riffles while gold hard to amalgamate will be retained in the riffles due to its specific gravity. The ground or placer ore is fed into the center of the mercury mixed with sufficient water to separate all particles and permit the material of high specific gravity to be thrown in contact with the mercury.

"The machine operates with a 1-h.p. motor. Shut-down time after clean-up is very short because of the ease of changeability of bowls. Where operating in a battery of two or more machines, an extra bowl can be used, entirely eliminating shut-down time for cleaning purposes."

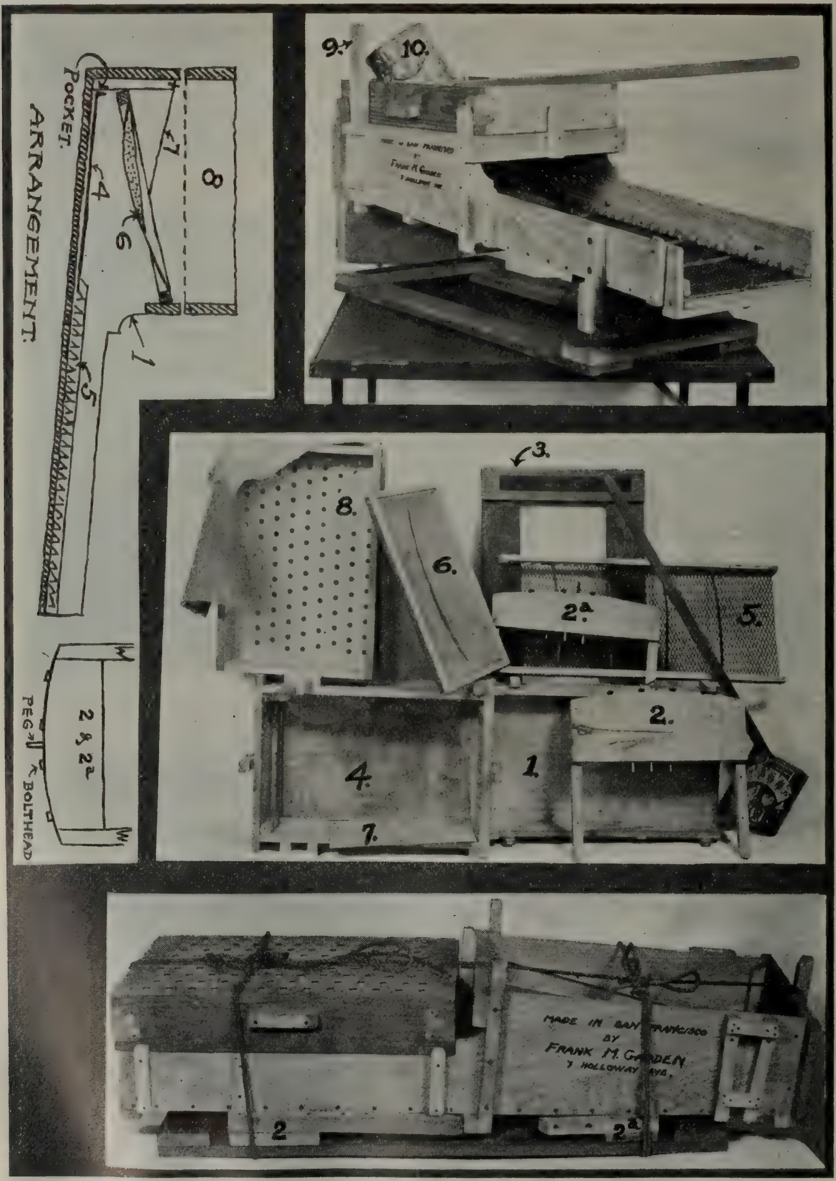


Fields Portable Power-driven Rocker.



Fields Portable Power-driven Rocker.

Fields Portable Power-driven Double-rocker. This machine, of the simple rocker type, is constructed so that it may be readily converted into a trailer and thus easily moved from place to place by automobile. It was constructed primarily for the owner's own use, but possibly will be built on order for others.


ARRANGEMENT.
POCKET.
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MADE IN SAN FRANCISCO
BY
FRANK M. GARDEN
7 HOLLOWAY AVE.
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Garden's Improved Rocker.

Garden's Improved Rocker.

"Referring to the diagram: Dirt washed through the tray falls upon the deflector and the apron, the deflector guides a portion of it toward the center of the apron. A large pool of black sand forms upon the apron and 'heavy' particles of gold remain in it. Material flowing from the apron falls into the pocket and then flows over the amalgamated plate, where the mercury will retain all clean gold which comes into contact with it. Particles which are not amalgamated, rusty gold and the platinum metals will be caught in the crevices of the expanded metal and burlap. The burlap will stop any mercury which may be washed from the plate. The notches of the riffle frame check the flow of water along the sides when the rocker is canted, helping to prevent loss from this cause.

"The pounding action, due to the bolt heads in the rockers aids the gold:

To bore down into the deposit of the apron;
To remain in the pocket;
To dig down into contact with the mercury;
To remain in the crevices of the riffles.

"This rocker will retain a very high percentage of fine and flour gold from any material suitable for concentration by a rocker.

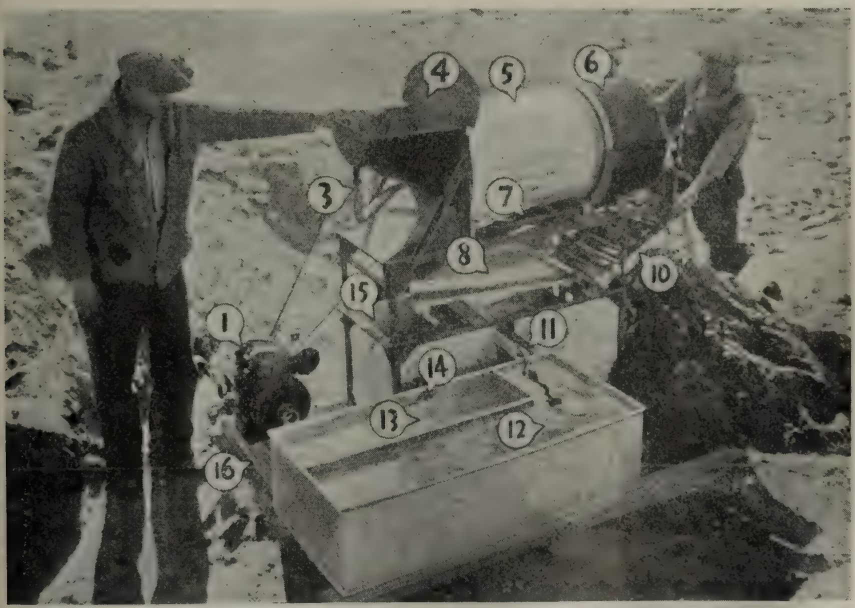
"If the riffles and burlap are cleaned up about every two hours, the loss will be very small indeed. This washing and replacing of riffles can be done in 15 minutes. The material from these cleanups should be stored and put through the rocker at the close of the day thus reducing the quantity of material to be worked in the final cleanup.

"Cleaning up is easily done, without the necessity of dragging the riffles out of the box from under fixed cleats, thus spilling some material over the end. Removal of four screws permits raising the riffles on end within the body so that nothing which falls from them in raising is lost.

"The rocker should be securely blocked in canted position and the riffles and all other parts washed within it, material and water flowing along the low side of the body into a pan under the end.

"Amalgamated gold should be scraped from the plate with a paddle of soft wood."

G.-B. Portable Placer Machine, New Model 12-S. The original G.-B. Portable Placer Machines were placed on the market in 1932.



G.-B. Portable Placer Machine—New Model 12-S.

The new Model 12-S embodies valuable improvements in efficiency and capacity. Its operation is readily understood when the numbers in the photograph are identified with the following simple explanation:

"(A) The tanks (12, 13 and 15) are first filled with water. The gasoline engine (1) is started and the sand or gravel is shoveled or fed into the feed hopper (4). Gravity flow of material and water pumped through the hose and pipe (3) carry the mixture into the combination revolving scrubber (5) and screen (6).

"(B) The revolving scrubber (5) turns the gravel over and over, washing it and disintegrating clayey or cemented materials. When the washed gravel rolls from the scrubber into the revolving screen the coarse and fine materials are immediately separated. The coarse oversize is tumbled from the screen into the discharge chute (9) and falls to the ground or into any receptacle provided.

"(C) The fine sands and gold pass through the screen and are washed down the launder (7) into the riffle pan (8). The riffle pan used in the G.-B. Model 12-S is of an entirely new type and design and operates crosswise at an average speed of 200 strokes per minute. The riffles are so shaped in the pan as to cause the gold to lodge and remain, while the gravel from which the gold has been removed rapidly works its way to the discharge end of the riffle pan by the combination of motion, slope, water and riffle design.

"(D) From the discharge end of the riffle pan the washed sand drops into the conveyor tank. It is there dewatered and discharged by the tailings conveyor flights (10).

"(E) The water overflows the conveyor tank and into the cross launder (11) and from thence into the external settling tank, which has two compartments (12 and 13). From the cross launder the circulating water first flows into the outer compartment (12) of the settling tank and then into the inner compartment (13). From the inner compartment gravity carries the partially clarified water through the flanged overflow pipe (14) into the main storage tank (15).

"(F) The external settling tank (12 and 13) permits the settling out, and removal by shoveling, of most of the circulating slimes which develop in the treatment of the gravel. This two compartment settling tank aids greatly in the clearing the water before it returns to the main storage tank (15).

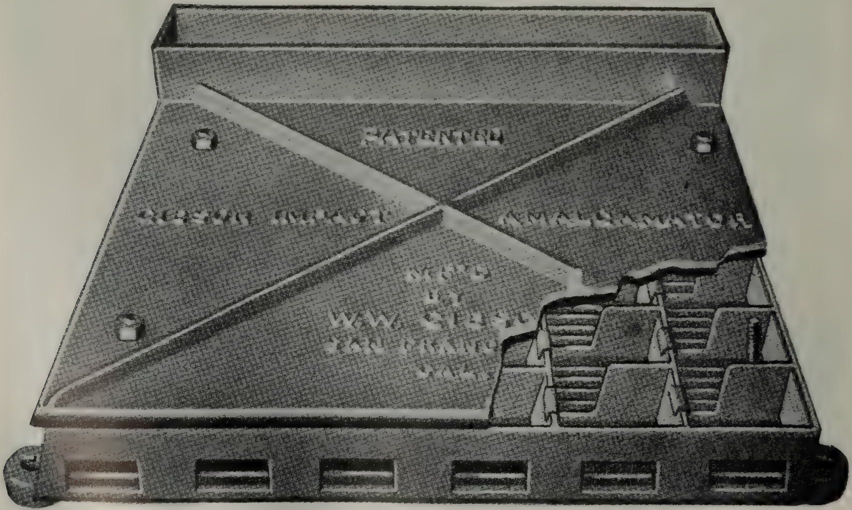
"(G) Where much clay is present in the gravel it is in some cases advisable to cut off the settling tank (12 and 13) and permit the water from the cross launder (11) to go to waste. In such cases, it is, of course, necessary to supply fresh water to the main storage tank continuously.

"(H) In any case, too great an accumulation of circulating slimes should not be permitted, as the buoyancy of excessive slimes might allow some of the gold to discharge over the riffles and be lost. The riffle pan (8) is readily removable. It should be cleaned as often as necessary to prevent loss of fine flour gold. How often depends upon the amount and character of the gold and the amount and value of black sands. It will be evident to experienced mining men that this caution applies particularly only where an important percentage of the recovery is in the form of flour gold.

"Dimensions: The Model 12-S G.-B. machine set up for operations stands 54" high, 84" long and 70" wide.

"Weight: Not crated, approximately 510 lbs.

"Portability: The machine can be taken apart readily and packed on two mules. Where roads permit it may be loaded on a trailer or in a wagon or light truck without being taken apart. Transport by airplane, of course, depends upon available space and carrying capacity of the plane.



Gibson Impact Amalgamator.

"Recovery: The Model 12-S G.-B. will recover 85% to 95%. This 10% range is due to the difference between flour gold and larger particles.

"Capacity: Where the bank run is not made up of excessively clayey or cemented materials, this machine will readily handle up to 2 yards bank run per hour. Under ideal conditions, it is capable of handling 2½ yards bank run per hour. Clayey and cemented materials necessarily lower the capacity.

"Water Required: Tanks hold 90 gallons of water. Since gravel in passing through the machine will absorb from 60 to 75 gallons per yard, it is necessary to have available that amount for replacement per yard of gravel treated.

"The small amount of water ordinarily required is one of the special advantages of the Model 12-S G.-B. machine—especially for working benches and old stream beds, dry stream beds, on the plains and deserts and in the mountains. These areas often offer the best opportunities for the placer miner, for either they have not been worked or have been worked but little, due to lack of water.

"Cost of Operation: The 1-h.p. gasoline engine will consume 1 gallon of gasoline in approximately 6 hours of continuous operation. Lubricating oil requirements are obviously very small. The design of the machine is such that necessity of replacement of parts is infrequent. The costs of unit operation are therefore very low. Extra parts may be obtained promptly at reasonable cost."

Get-More-Gold Pan. For the beginner, prospector or miner. Use a drop of mercury and cover silverplated portion of get-more-gold pan, put on the grizzly screen, to keep out coarse material, mix fine gold-bearing sand with hand, wash out, wipe the gold in center protecting cup. This get-more-gold pan will get 10 to 1 more fine gold than the always rusty black pan.

Gibson Impact Amalgamator, is a patented amalgamator made of aluminum. The No. 1 of 30-ton capacity has 42 compartments, 216 riffles and 12 feet in length of silvered plate. The No. 2 or 125-ton amalgamator has 99 compartments, 1000 riffles and 66 feet in length of silvered plate. Each compartment has a small silvered copper plate standing on edge. The bottom of each compartment has a grooved floor which leads the heavy particles of gold and amalgam towards the plate.

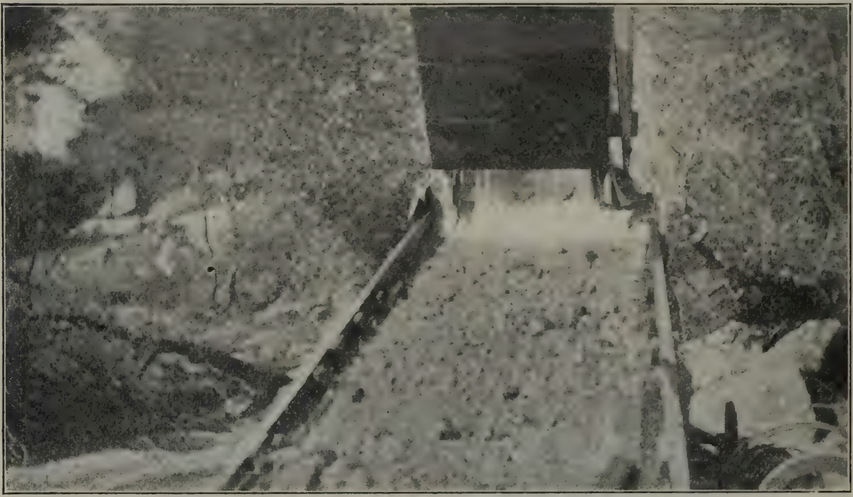
"In milling practice it is customary to attach the amalgamator to a concentrating table, the table feed passing through the amalgamator before entering the table distribution-box. For dredges or placer mines a special head-motion is furnished which gives the amalgamator the same motion that a concentrating table has. It is this motion which causes the impact wave.

"Rusty and tarnished gold is subject to a continuous backward and forward sand scouring and is finally brightened so that it adheres to the upright amalgam plates. It is also said to be impossible for fine gold to float through the Gibson amalgamator as the cover is provided with a rubber gasket which makes it watertight and all the feed has to pass under water from compartment to compartment."

Giffen Placer Machine. General appearance of plant.

Giffen Placer Machine. This machine which is adapted to localities where water is scarce is described by Haley[1] as follows:

"The machine consists of either a shaking or stationary hopper and water feed under pressure in the hopper, a shaking table with a side motion, set at a pitch averaging about 3 inches to the foot, and a type of riffle known as the Giffen riffle. The inventor claims that near Manhattan, Nevada, he could wash 40 yards of dry gravel with a supply of 9 gallons of water per minute, for 6 hours a day, the consumption being 80 gallons per yard. By the use of a trommel, the amount of gravel washed is materially increased. The dirt is fed into the hopper by an elevator. As the dirt dumps and spreads out, it is met by the water discharge, which thus gives a fair washing before the gravel reaches the table. The upper 18 inches of the table has another riffle, thus allowing the dirt to spread and cross the table in a thin wide stream, which causes a very fair degree of concentration to occur before the first riffle is reached. Four sections of riffle each 16 inches long were used, although it was only necessary to clean the upper one daily, the second every other day and the other two once a week. Where water is scarce, it is pumped back and used over and over. The plant can be moved and put in operation in less than one-half a day. The inventor claims that under ordinary circumstances the ground can be delivered, washed, and the tailings cleared away, so far as necessary, for 30 to 35 cents per yard."



View of Giffen Placer Machine. Taken when washing 24 yards per hour, at Rocklin, California.

Gilbert Concentrator: U. S. Patent, Serial No. 1477053; Mexico Patent, Serial No. 31380.

"The Gilbert Concentrator marks a signal advance in mining machinery development and satisfactorily meets every requirement demanded by experienced miners. In construction, the Gilbert Concentrator embodies the old, time-honored three-pan principle—screening from one pan to another with a series of classifiers and slimers. In other words, the most efficient placer mining method ever devised, the gold pan, is operated mechanically instead of by hand, saving 95% and better, of the gold in the process. Not only does this remarkable machine secure more than 95% of the gold, but it also saves every grain of black sand which usually contains other metals of high specific gravity.

"Compact in design, the Gilbert Concentrator is constructed throughout of heavy sheet steel and solid steel angle bars, with adjustable eccentrics for a longer or shorter jerk of the rocker tables. There is nothing to get out of order and every machine is built for long service and hard usage.

"In operation, the revolving barrel at the top is fed by conveyor from a hopper at the bottom. The revolving barrel grades out about 65% of the waste matter before the dirt or gravel passes on to Table No. 1, which has an endwise motion and grades out another 15%. From this table the material passes on to Table No. 2 into value pans with dividers and riffles, where the values are saved. Table No. 2

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[1] Haley, Chas. S., Gold Placers of California, State Mining Bureau, Bulletin No. 92, 1923, p. 68.

also has an endwise rocking motion. The value pan may be quickly removed for cleanup and another placed in the machine with no delay. From table No. 2 the material passes on to table No. 3, the concentrate table. Here everything is screened out except the black sand, which is trapped in a pan for saving. Tables are adjustable to levels of ground and work on tension rollers causing a dancing motion, thus preventing material from solidifying.

"The Gilbert Concentrator was particularly designed to handle material with very little water—just enough to form properly flowing slimes. This is one of the outstanding features of the machine and opens the way to operate in localities where only a limited supply of water is available. Only 7½ gallons of water to the cubic foot is required to operate the Gilbert Concentrator, and of this 6 gallons will sump back and may be used over again, as dirty water does not impair the efficiency of the machine. In a cubic yard, the loss of water is but 40½ gallons, as 162 gallons of the 202½ used is recovered.

"The Gilbert Concentrator is made in several standard sizes:

"5 cubic yards in 8 hours (hand machine), weight, 210 pounds complete. (Motor may be used with above if desired.

"10 cubic yards in 8 hours, weight complete, 875 pounds.

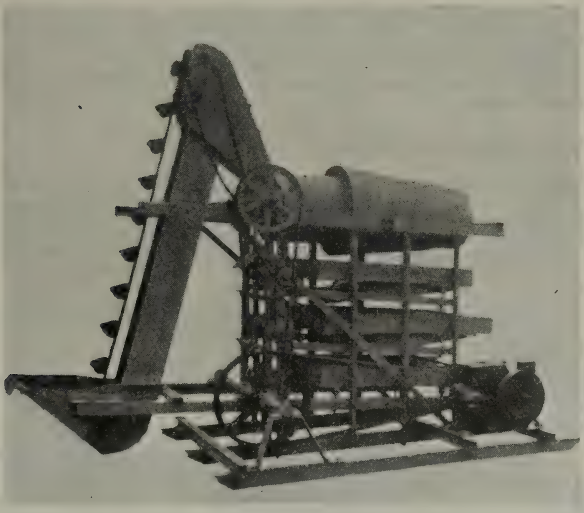
"25 cubic yards in 8 hours, weight complete 2550 pounds.

"50 cubic yards in 8 hours, weight complete, 3165 pounds.

"100 to 150 cubic yards in 8 hours, weight complete, 8000 pounds. (The above is equipped with an 8-h.p. engine.)

"Any of these standard units may be combined to suit special requirements.

"The Gilbert Concentrator will profitably work gravel running 75¢ per yard, and will net a good profit at values of $1.00 per yard or more. It has been demonstrated that this concentrator will handle clay more satisfactorily than any other machine made."



Gilbert Concentrator.

Girand Centrifugal Gold Separator.[1] Some 20,000 cubic yards of gravel have been handled by this centrifugal separator, which is entirely new in design and principle. It has recovered gold from $15 nuggets to flour gold that will float away in the pan, including flake gold, with low cost and high recovery.

"The machine consists of a double cone shaped rotating drum with greatest diameter in the center and open at both ends with hopper and feed spout to feed the gravel into the smaller end and tailings discharge from the larger end.

"The process employed by this machine utilizes the centrifugal force, within a rotating barrel. The principle involved, whereby gold and other heavy metals are separated from the materials in which they are contained, is that the centrifugal force increases the effective difference in the specific gravities of the gold, or metals, and the gravel to such an extent that a much faster separation is obtained than by any process using the force of gravity alone.

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[1] Described and illustrated in The Mining Journal, Phoenix, Ariz., November 15, 1932.

"The operation of the machine may be described as follows: Upon starting the machine, the barrel is empty, it is rotated rapidly (200 r.p.m.) and dry ore is fed into the barrel from the hopper. Due to the speed of rotation, the material entering the barrel is caught by centrifugal force and clings to the barrel. This is continued until sufficient material has been introduced to build up a collecting cushion, which assumes a cylindrical form. This is built up until its diameter is only a few inches greater than that of the discharge or outlet end of the barrel. The machine is now charged and ready for operation. The speed is now carefully regulated and must be under accurate control during operation, so that the particles on the surface of the collecting cushion will be on the verge of falling as they reach the top of the circle with each revolution.

"With the machine running at this critical speed, the particles at the top of the circle, have no weight, and those at the bottom, have double their normal weight. This keeps the collecting cushion soft and spongy, so that it does not pack or harden. With the barrel rotating at the proper speed, the ore, mixed with a small amount of water, is fed into the barrel from the hopper. This material being inside the critical radius is constantly churned and agitated, at the same time being under the influence of the centrifugal force within the barrel. As particles of gold come in contact with the spongy collecting cushion, they penetrate into the cushion displacing the lighter material.

"It requires only a few seconds for the ore to pass through the barrel during which time every gold particle has had an opportunity to become imbedded in the cushion. After the gold is imbedded, it is driven deeper and deeper, with each revolution until it is out of the unstable zone and in no danger of being displaced.

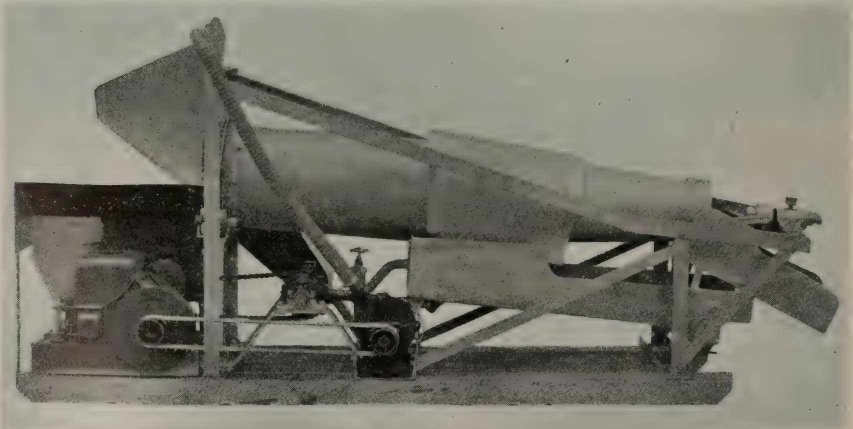
"The ore is fed continuously and the machine operated until it is desired to clean up. The usual practice has been to clean up once a day, but this is not necessary. After the run is finished the machine is stopped and the collecting cushion with its embedded gold is removed from the barrel. In the machine which has been handling 250 cubic yards per eight-hour shift, these concentrates amount to eight cubic feet, thus concentrating the ore 840 to 1. These 8 cubic feet of concentrates are in turn passed through a smaller, or clean up machine, which reduces the concentrates to one-quarter cubic foot, thus making a concentrate of 26,880 to 1. The final residue is panned to recover the gold.

"The outstanding features are: simplicity of operation, low cost of maintenance, mobility, ability to handle large yardages at low cost, high recovery of gold, and small water consumption."

Gold King Placer Machine.

"The Hartman 'Gold King' Placer Machine—No. 1—has a bank run capacity of approximately five cubic yards per hour. It is mounted on wood skids 7 feet nine inches long, and can easily be transported. Its weight is approximately 1000 pounds.

"It is equipped with a revolving trommel screen having a 30" by 14" scrubbing chamber, which chamber is equipped with lifting veins that rapidly pick the material up and drop it, similar to the action of the Ball mill. This trommel and washer is revolved at a speed of 50 R.P.M. The material, when discharged from the washing chamber, is passed over a ⅜" perforated conical-shaped screen, the fines (minus ⅜"), with the water, being dropped directly to the undercurrent board, the oversize being passed to a discharge chute which contains two traps for catching nuggets too large to pass through the screen.



'Gold King' Placer Machine.

"The box is built on the concentrator principle, having riffles set at 60°. As the gold is caught in the riffles, it is moved to a 'V' trough, located on one side of the board. It is then captured in the 'gold pocket' where the final clean-up is made.

"Suspended over the board is a vibrating riffle which has four bars, four inches apart, running at right angle to the riffles on the board. On one side of the upper riffle is attached two rods which run along the bottom of the V-trough, to assure perfect agitation and to bury the gold and deliver it to the gold pocket. This upper riffle creates considerable undercurrent and immediately submerges the floating gold. This upper riffle is vibrated by an eccentric giving approximately 1200 movements per minute.

"The concentrating board is driven by another eccentric of the same stroke and speed. This board and upper riffle work opposite to each other, which doubles the total movement for agitation purposes. The two eccentrics being opposite thrust, tend to counterbalance the drive shaft, giving unusual smoothness of operation. The heavy black sand is carried in suspension and the fine gold is moved downward by the undercurrent created by the upper riffle and the agitator. The heavier gold is captured by its own specific gravity.

"The machine is equipped with a 1½ H.P. water-cooled, Fairbanks-Morse gasoline engine, also a 1" Fairbanks-Morse Centrifugal Pump. The pump has a lifting range of about eighteen feet, and by placing the hose in sump or creek, the machine pumps its own water for washing purposes. After the material has been treated, the water may be run back to the sump, where it can be used over and over again.

"The consumption of gasoline is approximately two gallons per ten-hour day.

"The feed hopper on the machine is equipped with a built-in grizzley which prevents all rocks over two inches from entering the machine.

"The feed opening from the hopper to the machine is 7¾" in diameter, which definitely acts as a capacity gauge. The machine will handle all material, together with the required amount of water that can be put through this opening, making the machine a complete unit in itself—and *fool-proof in its operation.*

"The construction of the machine is of heavy metal throughout. The frame is all arc-welded, having few bolts to work loose. It is built to stand the roughest possible usage and fulfills a well-established demand of the small operator for a practical, moderate-priced placer machine.

"Their approximate sizes, capacities, weights, and prices are as follows:

"Gold King No. 0—Prospector, 1 cubic yard per hour, weight 125 lbs., price $275.

"Gold King No. 1, 5 cubic yards per hour, weight 800 lbs., price $650.

"Gold King No. 2, 15 cubic yards per hour, weight 1600 lbs., price $1,750.

"Gold King No. 3, 35 cubic yards per hour, weight 3800 lbs., price $4,000.

"Gold King No. 4, 80 cubic yards per hour, weight 8000 lbs., price $7,500.

"The above price and weight does not include feeder, stacker, or dewaterer, which we furnish if requested, cost plus 20%.

"All prices, f.o.b. San Francisco, or Los Angeles. State sales tax, extra. Time of delivery from ten to thirty days from date of order. Terms, 50% of purchase price with order, balance on completion.

"All machines are guaranteed to make a recovery of 96% or better of the free gold in the material being tested."

They have successfully recovered gold from the black sands of the Pacific Coast.

Gold Master Black Sand Machine. An improved amalgamating disc effective in the recovery of very fine gold from black-sand concentrates. Available in the following sizes:

No. 1-A. A very small disc, price $10.

1. Small machine, capacity 20 lbs. per hr., $20.
2. Medium machine, capacity 50 lbs. per hr., $50.
3. A large machine.

Gold Millers Cyanide Process. The following notes are quoted from a circular issued by the company:

"In our methods of extracting values by the use of cyanide we use:

"1. A protecting agent;

"2. A liquid precipitating agent;

"3. A restoring agent;

"4. An agitating mill.

"The Protecting Agent

"There are acid ores containing oxidized pyrites or acid earths which are very destructive to cyanide and these ores must be treated before being introduced to the cyanide solution. Ores or tailings containing sulfurets subjected to the weather will oxidize, forming metallic sulfates on the earthly constituents. These are only partially soluble in water, so that while water washings will assist in removing them, other treatment must follow to keep these objectionable salts from coming in contact with the cyanide and weakening it. The cyanide will partially be absorbed and decomposed by these substances if the ore is not treated to overcome them. All these objectionable salts can be held down and overcome by a reagent that is added and mixed with the ore as it is milled and crushed. This reagent holds down the objectionable salts and protects the gold, silver and copper.

"We have never found need of using a stronger solution than a .002% strength of cyanide and for treating ordinary ores a .001% or a .0005% strength solution is ample. This contention of using such weak solutions of cyanide may be questioned but by the proper use of our protecting agent we can hold down the substances which in ordinary processes absorb and decompose cyanide. With proper treatment of ores a startling degree of efficiency can be realized in collecting values by use of these small percentage solutions. We can guarantee a 95% recovery in practice.

"The Precipitating Agent

"In all cyanide processes a precipating agent must be used to liberate the values from the cyanide. Whether or not the process calls for some form of metallic zinc or an electrical current, the fact remains that not all the values can be precipitated; this is especially true when zinc is used for precipitating purposes; furthermore the zinc process is clumsy, lengthy and decidedly inefficient.

"We have produced a precipitating agent which, when administered correctly to the loaded cyanide solution, will force the cyanide to give up all of its collected values instantly. This precipitating agent introduces into the solution a radical which has greater affinity for the cyanogen radical than it does for the gold or silver; hence the gold and silver must leave the cyanide and be precipitated. The reagent is administered into the loaded cyanide solution at the rate of 1 lb. per lb. of cyanide used in the solution. This reagent can be used to precipitate foul, turbid solutions if need be; but with the proper treatment of the ore with our protecting agent there are very few instances where this is necessary.

"The Restoring Agent

"In almost all cyanide processes the cyanide solution, after it has been used for collecting and liberating values, becomes foul and inactive. The only commercial method of making a fouled, inactive cyanide solution active again is to add fresh cyanide and this, as well as being most costly causes an accumulation of inactive cyanogen radicals in such a manner as to render them active again and make them capable of collecting values again. So far as we know, this is the first time that this theory of restoration has been advanced.

"The Agitating Mill

"This type mill is very simple and easily operated; it consists of three or more agitating units, one or more precipitating tanks, a storage tank and, in some instances, a concentrator. When ore is to be treated a stamp mill is used for the initial crushing.

"The Cost of Processing

"The cost of processing ores, tailings or placer screenings by this method of cyaniding will of course vary, depending upon the character of the substances treated but, generally speaking, the cost will range from 50¢ to 75¢ per ton.

"These theories of using a protecting agent, a liquid precipitating agent and a restoring agent have never before been advanced. They entail something new in cyaniding. We have been working on these theories and their practical application for several years and they have been proven and substantiated by countless laboratory experiments and practical tests without number. These theories and their practical application will incur a conjecture of opinion, but when proven satisfactory to the scientific world they will revolutionize the commercial cyaniding of ores, tailings, etc. We are aware of the seeming impossibility of the methods outlined but be that as it may, the theories and their practical application have been proven to our entire satisfaction and with the proper opportunity can be proven to the satisfaction of anyone interested."

Grapp Dry Placer Machine.[1] The machine uses an entirely new principle which, briefly, consists of first feeding the sands which may be cemented together and also rock which may contain particles of gold. This same machine removes the greater portion of fine clay and other dust through an ingenious separating method.

"This attrition mill has an important bearing upon the successful operation of this new system as it prepares the sand for the next cycle of operation.

"From the attrition mill, the sand is automatically conveyed into the concentrating machine which consists of pans located one above the other. Each pan has a capacity of two yards of sand per hour. Rotating in each pan, there is a series of stratifications arms on which are fastened conveyor fins. Upper fins are arranged so as to propel outwardly the light materials out of the pans. A bottom set of conveyors is designed to propel the materials and metals of heavy specific gravity inwardly to a center discharge, which is continuous—no stopping for clean-up. Material coming from this discharge is the concentrate which contains gold, platinum, silver and other valuable metals.

"The principle of the system is simple as it works on the specific gravity of materials and since black sand and valuable metals have a high specific gravity of from 5 to 21 and that these materials are of a small percentage of the bulk, it is possible with this new system to separate such material from other light materials which have a specific gravity of 1 to 3 which is ordinary sand and the other bulk material.

"This system provides for concentrating of from one to two hundred which indicates ten pounds of concentrate to the ton. This concentrate is sacked and sent direct to the refinery for smelting. The machines are built from 2 yards to 40 yards capacity bank run. Very little power is required for operation as tests show approximately one horsepower per yard.

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[1] Illustrated and described in Western Mineral Survey, Salt Lake City, Utah, March 16, 1934.

"One engine will be supplied which will run the conveyors, attrition mill and concentrating equipment. Prices are lower than water machines due to the elimination of water equipment. Cost of operating this new system varies from two to twenty cents per yard, depending upon the characteristics of the sand which is being processed. One man can operate the Grapp Gold Machine which is of light weight construction permitting ease of transportation and getting into a difficult location."

Gravitational and Centrifugal Gold Saver. This machine is manufactured in Portland, Ore.

"It consists of a large round disc or pan one inch thick and four feet in diameter with a round plane or space in the center bottom of the disc a foot and one-half in diameter. There is a break in the plane and a gradual rise toward the outer rim or edge of the disc. This slope upward from break in the plane is at an average uniform rate of three inches to the foot of travel toward the outer edge. A series of round grooves or rings are cut in, or machined out, of the sloping surface of the disc so that each groove makes a complete circle. There are twenty-two of these rings or riffles, one above the other, each separated from the other by a wall one-fourth of an inch in thickness and three-eighths of an inch in height; each wall also makes a complete circle. The disc is mounted on a shaft and pedestal so it is exactly level. Then the rings or grooves are filled about one-half full of liquid mercury. Gold bearing sand is mixed with a stream of water and is poured onto the disc or pan while it slowly rotates.

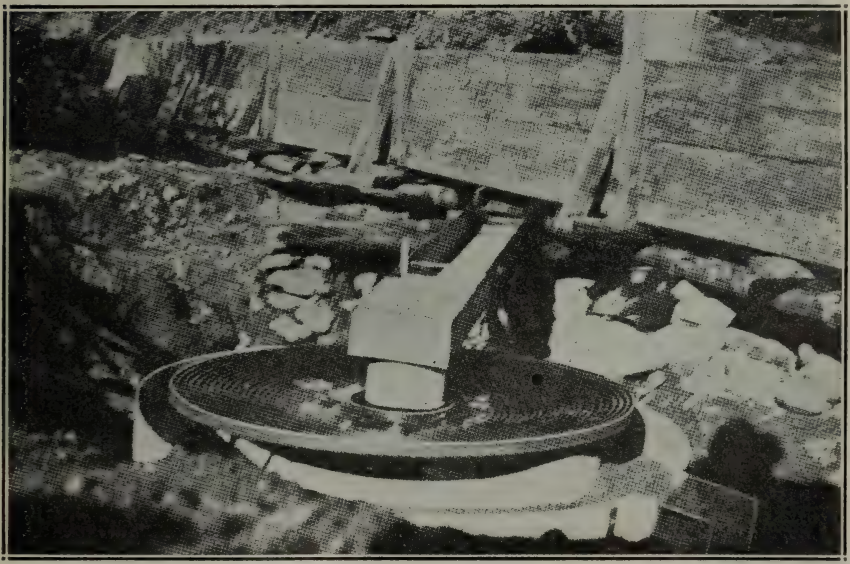


Figure I.
Gravitational and Centrifugal Gold Saver.

"This rotation has a tendency to do two things. (1) It causes the sand and water to circle from the bottom toward the outer rim or edge of the disc. (2) It has by virtue of this tendency the effect of compounding the force of gravity, thus causing the gold to sink deep into the grooves where it contacts the mercury for which it has an affinity, while the dirt and common sand and gravel are washed over the rim of the disc. This operation is kept up until the mercury becomes saturated with the precious metal, and then it is drained off the disc and the mercury separated by the usual means.

"Figure II shows the disc in actual operation on a placer property located on the Rogue River in southern Oregon. This picture shows the disc over which the gold-bearing sand is carried by water from the sluice box. The disc rotates at the rate of about three or four hundred feet of peripheral travel per minute. The water combined with the centrifugal action caused by the rotating disc, carries all the tailings over the outer edge of the disc, while all of the gold, or other precious metals is caught in the rings or grooves on the face of the disc. Free gold in this operation naturally combines with mercury as set forth in Figure I. Gold, being heavier than other materials, naturally travels on the bottom of the sluice box. When the underflow is taken from the bottom of the sluice box through a screen and directed over the disc it naturally carries with it all the precious metal. This is directed over the disc and is captured in grooves by the mercury as suggested in Figure II, while the large stream of water carries away all of the tailings.

"This gold saving machine is being built in two sizes, the rings or grooves being the same width and depth in either size machine. The disc for No. 1 machine is two feet in diameter and weighs about one hundred pounds. It is made of cast iron. Its capacity depends almost entirely on the amount of water available for the operation. In other words, if there is only enough water to wash ten yards that will be the limit of the operation; if there is enough water to wash one hundred yards or more, the two-foot disc will take care of it.

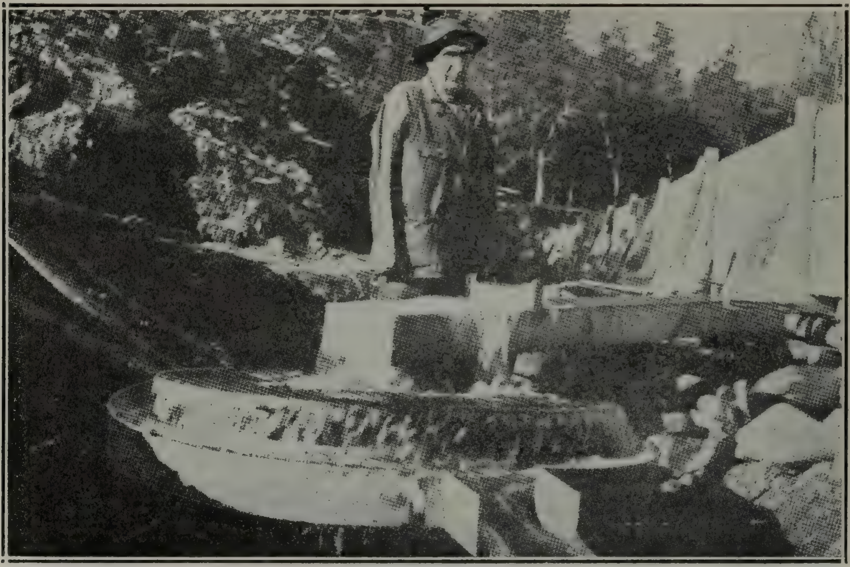


Figure II.

Gravitational and Centrifugal Gold Saver.

"In an operation of this kind the undercurrent from the sluice box should be drawn through a screen not coarser than one-eighth of an inch mesh.

"Size No. 2, which is the size from which the Figures I and II were made, weighs 610 lbs., is four feet in diameter and contains twenty-two riffles. It is believed by our engineers that this size will take care of any amount of yardage, sand and gravel, that the water capacity will properly break down and wash. It will handle up to five hundred or even seven hundred yards, depending upon the physical conditions.

"For operations where the water supply is limited and water must be conserved, the inventors have prepared a rotary screen in which to wash the gravel. This screen is so constructed that the fine gold is washed through the revolving screen and carried on to the disc by the same means indicated in Figure II, while the coarse gold is caught in the riffles. The water, after performing its duty on the disc, may be caught in a settling tank and pumped back through the screen again if the water supply is meager enough to require such care.

"The concentric rings or grooves shown in Figure I are intended to be filled about one-third full of liquid mercury. The experience of the inventors and engineers to date indicates that the first six rings or grooves from the center toward the rim catch all the values, so it is believed it will be unnecessary to fill the rings on the outer edge of the disc. Twenty or thirty pounds of mercury are sufficient for the two foot discs, and fifty or sixty pounds are ample for the four-foot disc.

"One of the interesting discoveries in connection with this invention is that mercury is never lost or wasted as long as the disc is intelligently operated.

"Another interesting discovery is that coarse gold may be reclaimed and saved without the use of mercury."

Grubstaker Placer Rocker. The Grubstaker amply fills the need for a small, practical gold recovery unit for the miner of limited means.

"The Grubstaker is an end motion rocker, designed and constructed in accordance with sound, proven principles of gold recovery and is no experiment.

"This unit can be readily transported in an automobile or easily taken anywhere a prospector or miner could go.

"Very little skill is required to make a very high recovery with this unit.

"This unit can be operated in localities where very little water is available.

"The Grubstaker will readily make a very high recovery of all classes of gold found in the gravels of any fresh water stream.

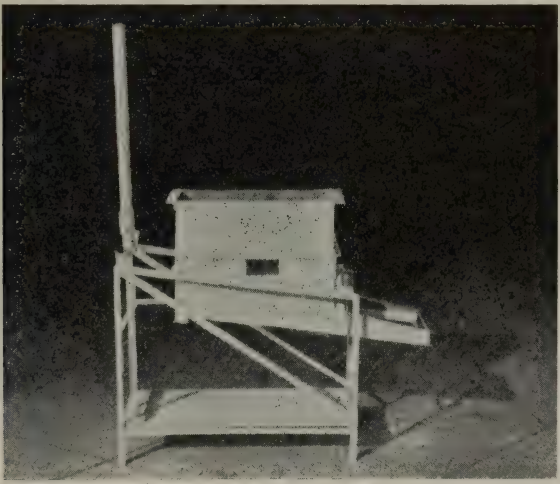
"The following is a general description of the Grubstaker and its operations:

"The frame is of light angle iron electrically welded together into a very substantial support for the rocker box, which consists of a removable hopper, set upon a suitably constructed box, set in hangers hung in the frame; under the hopper is placed a fabric apron stretched on a light wood frame at the base of which is placed a small removable metal trap which can be employed as an impact amalgamator if desired; in the bottom of the box is placed any suitable gold recovery medium, heavy brussels carpet covered by wire cloth is furnished as standard equipment which will be found to be very successful for the purpose.

"The box and hopper are constructed of 24-gauge iron.

"The agitating motion is achieved by mounting a suitably constructed lever on the frame and connecting this lever to the rocker box by means of a connecting rod.

"A wide range of agitating motions are available to the operator. However, the following procedure has been found the most practical.



Grubstaker Placer Rocker.

"Fill the hopper with the desired amount of gravel, pour water on the gravel with the dipper, as water is poured impart from 3 to 5 short sharp strokes to the rocker handle, then as water is dipped impart 2 or 3 long smooth strokes to the handle, then as water is poured again 3 to 5 short strokes and so on until the operator deems the gravel sufficiently washed for the purpose, then dump the hopper, refill, and continue as before.

"The operator will soon develop a practical motion best suited to the individual.

"It is not necessary to use a gold pan in the operation of the Grubstaker—the gold-bearing sands which pass through the hopper bottom drop upon the fabric apron which acts as a preliminary retardent to the gold, the gold works down the apron much slower than the sands, therefore the gold contained in the hopper of gravel just washed is readily visible to the operator as each hopper of washed gravel is dumped, thereby making it easy to determine the approximate value of the gravel being washed.

"The Grubstaker is easily cleaned up in a few minutes time.

"The apron furnished is of blue denim, a material which readily discloses the presence of gold when wet.

"Amalgamation may be carried on in the trap if desired, although it is not necessary to effect a high recovery with this unit.

"There is nothing to shake loose in the Grubstaker, as all parts are either securely welded or brazed where joining was required.

"Besides the gold-saving medium placed in the box there is a save-all lip at the discharge end of the box which is effective in saving any gold which may work down so far. The lip is also very handy as a concentrating trap in cleaning up.

"Black sands will not interfere with the proper operation of this unit.

"The capacity of this unit is about a pan of average river gravel in one minute.

"The Grubstaker will readily return very good wages from any gravel from which one man can pan 50¢ per day.

"The Grubstaker will be found to have considerably more capacity than its appearance indicates and must be seen in action to be fully appreciated.

"This unit will also be found to be an ideal recovery unit for the use of prospectors and mining engineers in the practical sampling of gold bearing gravel.

"The total overall dimensions of this unit is 24 inches long, 12 inches wide and 19 inches high when knocked down ready to move on.

"The total weight is 22½ pounds.

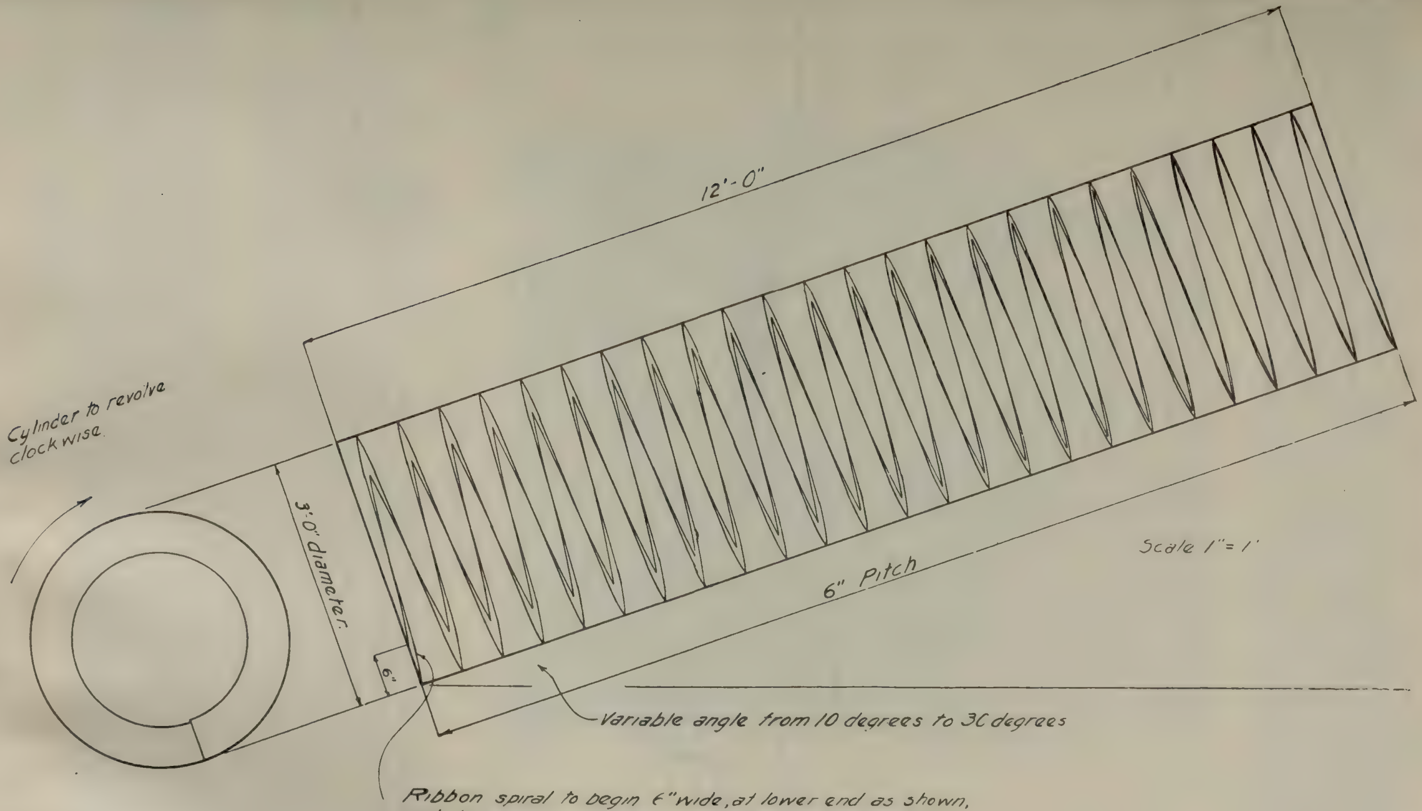
"The Grubstaker is finished in aluminum bronze lacquer.

"The introductory price of this unit is $20, f.o.b. Oakland, Calif."

Gwynne Super-Gold Pan. This is a modified rocker with horizontal oscillation which can be built of ordinary lumber at a cost of about $4 for material. The 'One-Man' size has a capacity of about ¼ cubic foot (2 gold pans full) per minute and is hand operated. This apparatus can be used wet or dry. It also can be built, in proportion, of larger capacity, if desired. One is now being demonstrated in San Francisco.

A detailed blueprint giving plans, specifications and instructions for building and operation of the Gwynne Super-Gold Pan is for sale by the inventor at $1 a copy.

Hammond Dry or Wet Placer Machine. This apparatus consists of a metal cylinder or tube open at both ends. Welded inside of this is a ribbon spiral. On a cylinder 12′-0″ long by 3′-0″ in diameter the spiral is 6″ wide at the lower end and tapers uniformly to zero at the upper end. It is wound on a 6″ pitch. Smaller prospecting sizes can be made in proportion. The cylinder is mounted on rollers and is set at a variable angle from the horizontal, usually 10° to 30°. It is revolved by means of a belt or gearing. The feed hopper is located at the upper end and the feed is introduced about ⅓ way from the top. As the cylinder is revolved clockwise (looking up) the material is rolled along and tumbled over the spiral ribbon. The gold or other heavy mineral remains in the bottom of the spiral trough and is gradually carried up and out the upper end in a thin fine stream. The lighter material passes over the spiral ribbon and falls out the lower end. It is claimed that the machine will work equally well on dry material or in water. The inventor states that a medium size machine can be built for $250. A saving of 90–100% is claimed.

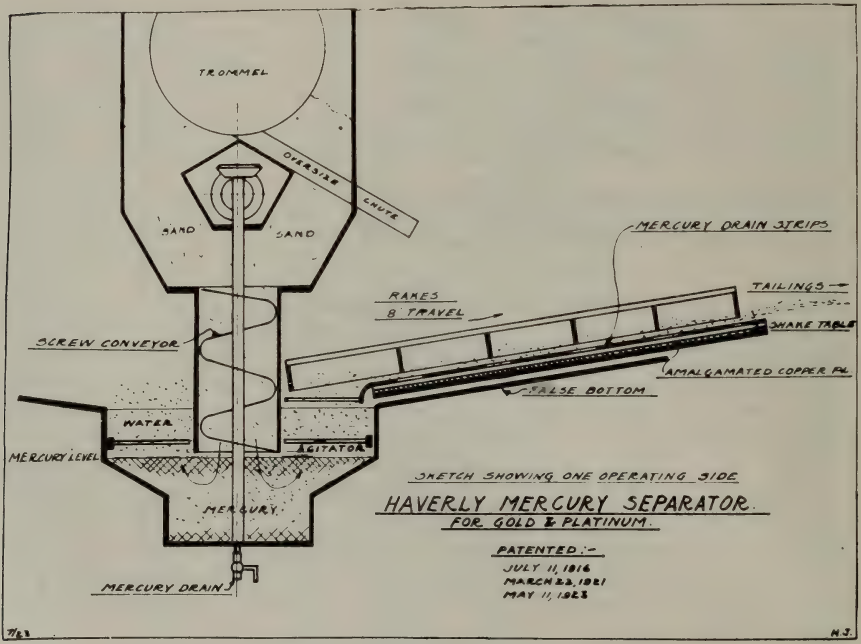

Cylinder to revolve clockwise.
12'-0"
3'-0" diameter.
6"
6" Pitch
Scale 1" = 1'
Variable angle from 10 degrees to 30 degrees

Ribbon spiral to begin 6" wide, at lower end as shown, and to narrow uniformly to zero at upper end

Hammond Dry or Wet Placer Machine.

Hanssen Process. This process and machine was formerly controlled by a Seattle company. It is said to have proved quite successful in recovering gold from black sand on the beach of Graham Island, British Columbia. A machine was set up at Bandon, Ore., and a working model was placed on exhibit in Crescent City by the inventors. Further details in regard to it will have to be obtained from the manufacturer.

Haverly Mercury Separator, for gold and platinum. This machine is patented and it has been built and used with reported success. It takes very little water to operate so may be used in arid regions. The Haverly machine does not depend entirely on amalgamation for extracting but also utilizes gravity. The entire pulp or feed is forced below the mercury surface, the lighter material rising and being removed and the heavier particles, gold and platinum settle to the bottom of the mercury bowl. It is claimed that it will save the finest particles and leafy gold ordinarily carried off by water.


TROMMEL
OVERSIZE CHUTE
SAND
SAND
MERCURY DRAIN STRIPS
TAILINGS
RAKES 8' TRAVEL
SHAKE TABLE
SCREW CONVEYOR
AMALGAMATED COPPER PL.
FALSE BOTTOM
WATER
AGITATOR
MERCURY LEVEL
MERCURY
MERCURY DRAIN
SKETCH SHOWING ONE OPERATING SIDE
HAVERLY MERCURY SEPARATOR
FOR GOLD & PLATINUM.
PATENTED:-
JULY 11, 1916
MARCH 22, 1921
MAY 11, 1923
7/23
H.J.

Haverly Mercury Separator.

"The sketch plainly shows the method of operation and the principles involved. The apparatus consists of a trommel for removing coarse material, a sand hopper from which a screw conveyor draws the fines and forces them below the mercury surface in the bowl beneath. The surface of the mercury is covered with water which is kept in agitation and mechanical rakes are provided for removing the tailing. A shaking table with amalgamated copper plate is placed below the rakes to recover any escaping gold or quicksilver.

"This machine is adaptable to both placer and mill work."

Harris Portable Dry Washer. (Single and Double Type.)

"These machines are for the purpose of recovering gold from placer gravel without the use of water.

"This is accomplished by means of a continuous air current produced by fans acting through fixed inclined riffle screens placed over the fans. The gold bearing material, being shoveled or fed upon a screen being discarded, and the undersize passing into a bin, from where it feeds automatically down upon the riffle screens below and with the combined action of the air current and inclined riffle screens, it discharges the tailings below.

Harris Portable Dry Washer.

"One inch above riffle screens and on same incline, baffle screens are placed to deflect any fine gold back upon riffle screens which may be blown against them, and at the same time allowing all dust laden air to pass through into a dust chute to be carried away from operator of machine. Baffle plates, located in fan boxes and under riffles, deflect the air in such a manner as to keep a space above each riffle clear of material to allow concentration of gold back of riffles.

"All fine gold which works through riffle screens is recovered in traps below in fan boxes. Recovery of single fan machines is 100% of pinhead size placer gold and larger together with a quantity of finer gold. Capacity, all one man can shovel in a day, of ordinary gravel, upon the one-fourth-inch mesh screen.

"The double type machine is all that the name implies, having two fans, two sets of riffle screens, two sets of baffle screens, and two opportunities of recovery. This machine is preferred, as it can be operated either double or single. Double where fine gold predominates and single where the gold is pinhead size and larger.

"The two sets of riffles in the double type machine are placed in such a manner that any fine gold lost from the upper set of riffles feeds automatically down upon the second set of riffles and is recovered all with the same effort and time as single machine recovering what upper riffles may lose.

"Two gallons of water are ample for cleaning up after a day's run. Machines are constructed of three ply reinforced Douglas fir for lightness and strength, all screwed construction, ball bearings throughout. They can be operated by hand or with one-half horsepower gas engine. By attaching a bicycle wheel they can be wheeled over rough country.

"Weight of single machine about 45 lbs.

"Weight of double machine about 60 lbs."

Harris Magnetic Concentrator.

(A) Built for the purpose of working all gravels containing black sands, metallics (sulphides) and fine gold, and all black sand deposits carrying gold and metallic values.

(B) The machine consists of six (or more) magnetic sections, each comprising a complete magnetic field within itself.

"Action 1. As the material passes over each section, the magnetic field retains all materials subject to magnetic influence and all material thus retained builds up into a spongy mass, alive and constantly in action, and all non-magnetic material, either oxides or metallics of 4 or more specific gravity, will be caught by the sponge in magnetic field.

"Action 2. All magnetic material retained on the magnetic plates is of a porous nature, standing up in loose spongy mass that will catch and hold all particles of free gold regardless of size or form, for the reason that when the particles of gold in gravels come into contact with the metallic sponge, the hydraulic force of the water drives them along the surface of the plates, under the sponge, until in course of a short time they will become amalgamated in the mercury traps. It will thus be seen that by either process, Action 1 or Action 2, all values, of every nature, are recovered.

"It will thus be seen that in operation this machine accomplished two mechanical results.

"(1) It saves all metallic and sulphide values that the black sands carry.
"(2) It saves all free gold values by amalgamation in the mercury traps.

"(C) Where gravels carry considerable heavy rock and large size pebbles they should be screened down to ⅛" or ¼" mesh, depending upon size of the metallics contained. This is for the reason that all values found in such materials are invariably within these sizes.

"(D) When all magnetic plates, with exception of the last plate (which acts as a pilot plate) have become fully charged to capacity, as much as the magnetic field can hold, the clearing of the machine is done as follows:

"(1) Cut off sand feed.
"(2) Throw by-way cut-off in lower end of machine.
"(3) Release electric switch, demagnetizing all magnetic fields.
"(4) The continuing flow of water will carry all concentrates to the ore bin.
"(5) Restore by-way cut-off.
"(6) Return electric switch to contact, thus restoring magnetic fields.
"(7) Open up sand feed.
"(8) When mercury traps are sufficiently charged clean up, either through drain holes or with a fine screen spoon.

'The Harris Magnetic Concentrator is adapted to the following additional uses:

"Upon quartz properties, containing small quantity of magnetic materials, when ground to the fineness ordinarily required for recovering of such values.

"For working over old mill dumps, waste dumps containing iron ores (either hematites or magnetites).

"For working original iron ores, concentrating same cheaper and with less equipment than processes now in use.

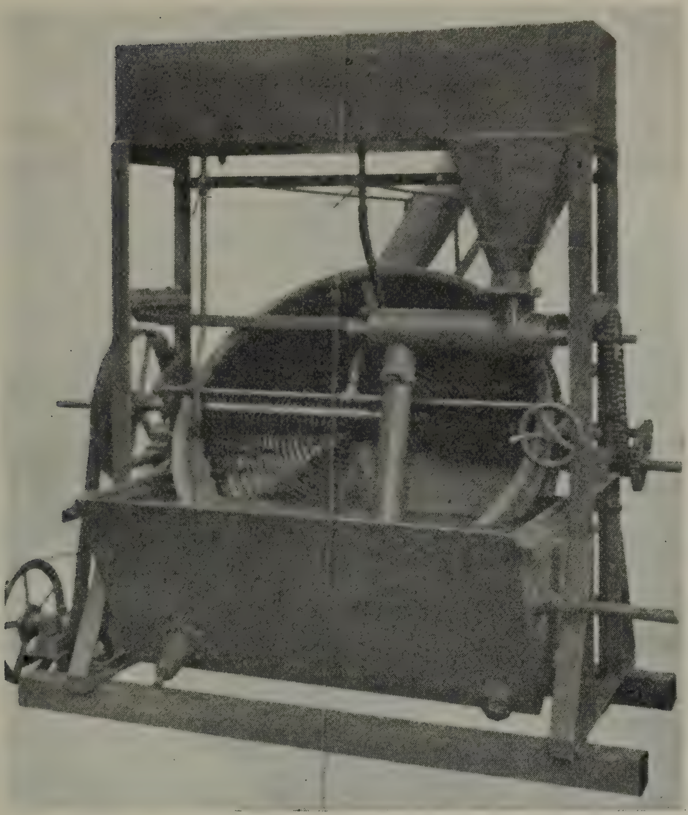
"Also for all materials such as silica sands."

Hatton Process. This gold recovery process was developed in Seattle, Wash. No details are at hand.

Haskell Machine. This machine has been built and used in the field, but data are confidential.

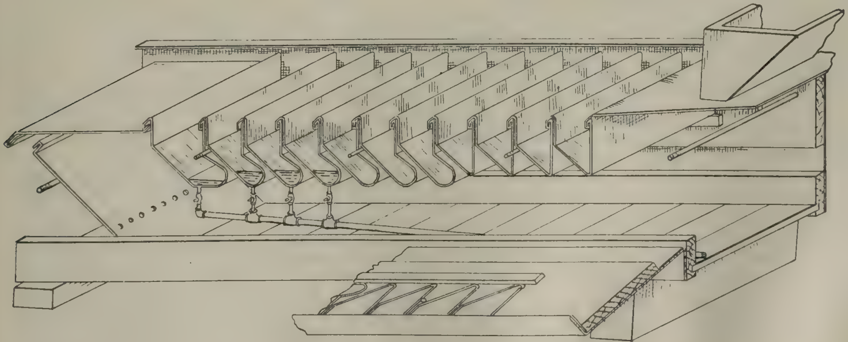
Healy Machine. This apparatus does not differ greatly from a number of other machines. It uses a revolving trommel, shaking sluice with steel riffles and is operated by a 1-h.p. engine.

Hinkley Spiro Concentrator. The outstanding features claimed for this machine are: High percentage of recovery; minimum horsepower—not more than ½ h.p. required; no vibration—18 to 22 revolutions per minute; constant operation; small water consumption—only 60 to 70 gallons per yard; quick and easy adjustment; small floor space—6′ by 4′; no foundation required—total weight 1350 lbs.; little depreciation or replacements; concentrates can be deposited in locked container if desired; stubborn clay placers will yield a high percentage under proper handling.



Hinkley Spiro Concentrator.

Hinrichs Black Sand Process. Stated to be an entirely new process for the recovery of fine gold from black sand. No details are at hand.



Hofex Riffle.

Hofex Riffle. An improved riffle for the recovery of the heavier precious metals from finely divided material. The plate shows a perspective side view of a riffle trough embodying the invention, a side element of the trough being shown fragmentarily and in displaced position, the four riffles to left are of copper for amalgamation.

Sizes to meet individual requirement are built to specifications.

Holt Rubber Riffles.[1] The distinctive features of the Holt rubber riffle is a swirling eddy that is said to save both flake and flour gold.

"The device consists of a rubber pad or mat with thousands of pockets in the shape of truncated spheres. The rushing water swirls in these pockets and keeps the sand and gold moving, except the flake or flat gold which sticks to the concave walls of the cells. The rounder particles of gold roll and tumble against the eddy side of the cell and remain there, while the upward current of water carries the sand away.

"These soft rubber riffles can be rolled into a miner's pack and carried anywhere a miner wants to go. They weigh only two pounds each. To begin operations, it is only necessary to dig a trench, put down the riffles, and start the sand and water through.

"In hydraulic mining the rubber riffles may be placed in the main sluice with pole riffles or angle iron above to keep off the large rocks, or a grizzly may be put in the flume and only the fine sand permitted to run over the rubber riffles. The Holt 'never clog' grizzly may be used in the main sluice to divert the fine sand and gold particles to such an undercurrent. The 'never clog' grizzly is a grooved rubber mat with long tapering 'fingers' at one end. These are installed with the fingers downstream and supported by a piece of iron plate. This plate should be made movable and adjusted so that just the proper amount of fines will pass through. In tests that were made ⅞ of the sand was eliminated and yet all the gold was saved. It was found that if the gravel in the sluice is not agitated for about 10 feet above the grizzly practically all of the gold will be sliding along the bottom and will consequently pass through the grizzly.[1]"

Huelsdonk Improved Concentrator. The Improved Huelsdonk Concentrator, in complete assembly, has every feature of design and construction which practical experience has found necessary to contribute in any way to greater efficiency, strength and durability.

"It is particularly designed to thoroughly disintegrate, cleanse and scour the materials and to separate and save the values from gold-bearing gravels and placer materials in one continuous operation. Under favorable conditions where free values exist it can readily be adapted to the successful handling and concentrating of other ores.

"To begin operation the water supply is turned on and the hopper allowed to fill up to a level with the grids. Bank run gravel, including boulders up to 10 inches diameter, is then fed into the disintegrator and the power turned on.

"The violent rocking motion of the disintegrator, together with the lifting and surging of the water from below the screens and grids causes the mass of material to roll and grind. The boulders contained in the mass help with the grinding and scouring, breaking up lumps of clay, gumbo and cemented graved and also scouring the oxide coating from dirty or rusty gold.

"The surging of the water, together with the motion given the disintegrator, keeps the screens free from clogging.

"The oversized materials, which have now been thoroughly scoured and cleaned, are automatically crowded across the grids and out the discharge chute to be disposed of on the tailings pile. Any nuggets too large to go through the screen are safely held by the grids in the hopper.

"The screened material goes to the bottom of the tank and is carried out, mixed with water, through special adjustable feed gates and into the distributor feed troughs of the table. The screened material enters the feed trough with just enough water to hold the mass buoyant and the shaking and bumping action of the table causes the mass to sift through the feed ports of the trough, where it is sent across two baffle plates, then on to the riffle deck. As the mass is kept stirred up and held buoyant at all times, the heavier values and sands precipitate through the mass to the bottom and are held in the riffles or grooves which run lengthwise with the table. The motion of the table is a lengthwise shake and slight bump, controlled by a special adjusting device, and this motion causes the material to move forward down the table. At the feed end, the riffle deck begins with six riffles or grooves which are of unequal length. As the material is then forced down the deck it is fed from one riffle to the other, allowing the lighter materials to be crowded overboard into the main tailing trough which runs the full length of the table, after the material has traveled down the riffle deck to the lowest point. The riffle deck being higher at the feed end, all the gangue has been crowded overboard and in the last remaining riffle or groove only the black sands, sulphides and values remain. From this point they are crowded up a slight raise and on into the final cleanup end of the deck. Here the square tank of the extreme end of the machine furnishes a supply of clear water for the final separation and cleanup. The gold and other heavier values find their way into the special locked container where they remain and the black sands and sulphides are crowded back and out into a special trough where they can be saved.

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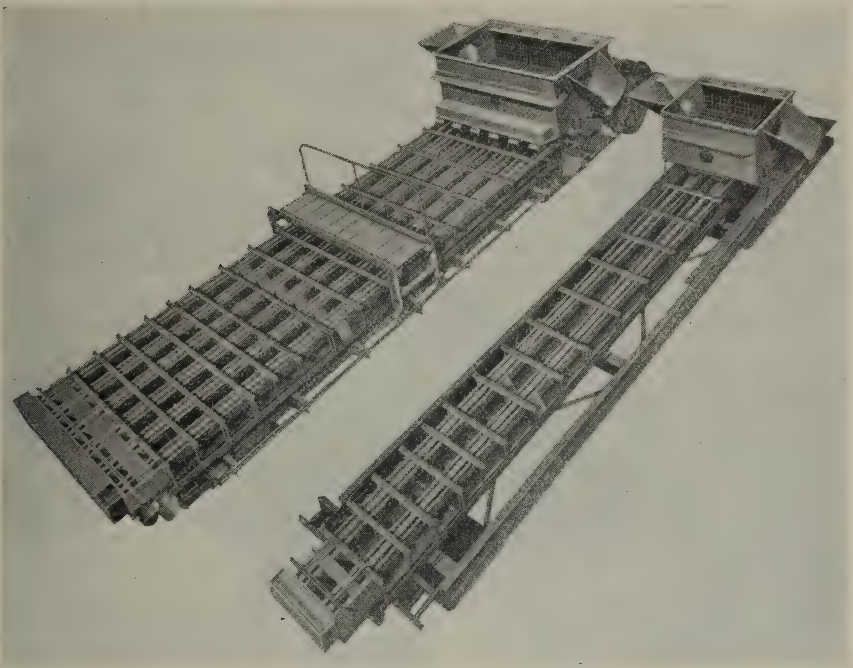
[1] Illustrated and described in the Mining Journal, Phoenix, Ariz., Feb. 15, 1933.

"Once properly adjusted as to water and material supply and the proper motion obtained, no further attention is required and the cleanup is practically automatic.



Huelsdonk Improved Concentrator, 2-Unit and 6-Unit.

"The improved Huelsdonk concentrator is made in two models—the 2B-4 Riffle, which will handle eight cubic yards of bank run gravel per hour, and the 6A-12 Riffle, which will handle 24 cubic yards per hour. Where larger capacity is required a battery installation of sixes is recommended.

"Power may be applied to the Improved Huelsdonk Concentrator either by direct gear reduction to the line shaft or by belt and pulley drive, using either electric, water, or gasoline power."

Improved Gold Pan. A pan with burlap on the bottom held down by ½-inch screen, riveted in. It is claimed to speed up panning about three times.

Johnson Dry Concentrator. The following notes and drawings have been supplied by the manufacturers:

"The machine is built on entirely new ideas, and has several new features, which, together with the controls and adjustments make it a simple, efficient, and practical machine. It is built entirely of steel, on a strong, rigid, tee and angle iron frame, and is perfectly capable of standing the rough usage a machine of this class is subjected to.

"The table is 2′ wide and 12′ long. The machine is 3′ 6″ wide, and about 16′ long, and the hopper is 18″ high. The machine weighs about 3000 pounds. It can be taken down for shipment, the heaviest part weighing 200 pounds.

"The feed is a pocket roll feed of a new design. The pocket extends the full width of the table, and places the gravel and pulp in an even layer the full width of the table. The feed roll is driven by a ratchet disk and lever (4) and ratchet (3). Controlling lever (5) carries a guard which disengages ratchet (3) by placing lever (5) in the central position. There is no motion imparted to the feed roll by moving lever (5). The speed of the feed roll can be increased from nothing to the full capacity of the machine while the machine is in action. Thus the operator, by simply moving lever (5), has complete control of the amount of ore fed from the table.

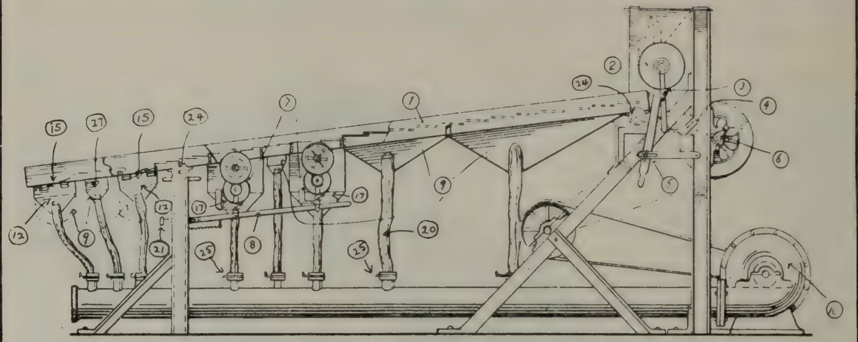


FIG. A
Elevation

Johnson Dry Concentrator.

"The method of applying the air is different from that in general practice. The air is not forced up through the ore, but passed between the riffles in a line that the ore is traveling in, which does not blow the fine values on top to be settled again or lost. The surface of the table is composed of a period of steel riffles one-sixteenth of an inch thick and over-lapping each other about one and one-half inches, and held apart by washers one-eighth of an inch thick. The air is admitted through pipe (10), slide valve (25), flexible hose (20), into air pan (9). There are a number of separate air pans to enable the operator to control the amount of air under different parts of the table, which is very essential. The air passes between the riffles in line with the traveling ore, helping its action down the table and causing an agitation the full width of the table at every riffle. The agitation causes the heavy particles to settle to the bottom as they pass down the table.

"The main feature, and one that has made the machine a success, is a method of collecting the concentrates. It is composed of a corrugated roll (11), 5½ inches in diameter. There are two of these rolls. They extend across the table as shown in collector feed detail. The rolls are driven by a train of gears (7) and ratchet. The ratchets take their motion from a lever or rod (8), which is controlled by a set screw (21). By screwing set screw (21) in or out, the speed of the roll can be increased or decreased while the machine is in motion. By this control the operator can take just as little or as much concentrates as he desires. The advantage can be seen in being able to control the amount of concentrates taken, to suit the character of the ore handled. This is said to be a feature no other machine has.

"The operation is this: the heavy particles, having been settled, pass down the table until they pass riffle (18), which is about ⅛ inch above the collecting roll (this space can be adjusted to suit the ore handled). There is an opening under the roll of about 5/16 of an inch (this also can be adjusted). Across the opening is riffle (19), with a beveled retarding strip attached to it. There is a 1/16 of an inch opening between the roll and the retarding strip. The object of the opening between the roll and the retarding strip is to allow the air to pass through into the ore. The air passes into the air pan (17), which is also the concentrate hopper, and passes around the collecting roll both ways. The heavier particles drop down through the opening and the air onto collecting rolls, and are carried into the hopper (17), to be discharged into a concentrate bin (not shown). The lighter particles, and also the larger pieces, are worked up the inclined surface of the retarding strip (19), and go into the tailings. Nearly all the values are caught in the first roll. The second roll is more for safety. The concentrates from it are run over again as they are very low grade. The collecting device is the main feature of the machine.

"The last, but not the least feature, is the nugget collected. It will be readily seen that no large pieces can get on the collecting rolls through the small opening. They are worked over the retarding strip (19), and pass down the table to the nugget collector (15), of which there are two. They are composed of a set of inclined riffles (15), forming a pocket. The air passes into the pocket between the riffles (15), keeping the ore agitated. The heavy nuggets settle in the pocket, which is hinged to the table by loosening a thumb nut. The nugget collector can be dropped and its contents taken out while the machine is in operation. This saves the large nuggets which otherwise would go into the tailings.

"There is a device at the lower end of the table for raising or lowering the table to any desired pitch, for different classes of ore.

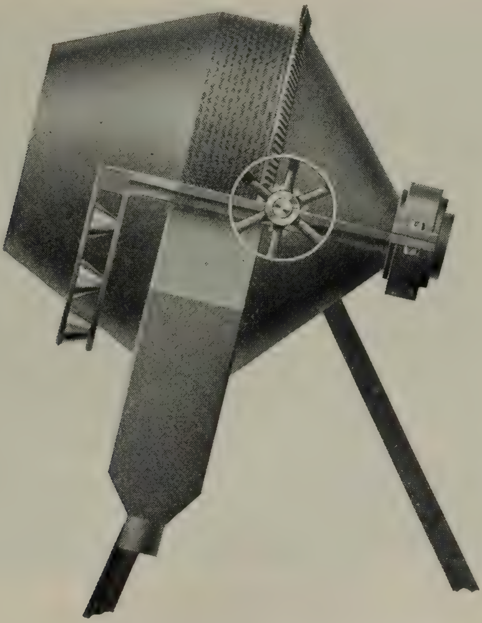
"The table is actuated back and forth by pitman (6), and by moving the pin in or out in the slot, any desired stroke may be given the table.

"This machine will handle any fine sand or it will handle loose gravels that have been passed through 1¼" mesh screen without any further classification. It will also handle concentrating ores that have been crushed through ordinary mill screens. It makes about the same saving of values in this class of pulp as a water table will make. Its capacity is from two yards to six yards per hour.

"Taking the construction of the machine, and the new features, together with the adjustability and control of the different devices while the machine is in operation, this machine is suitable for the handling of a wide range of material. The machine is simple and can be handled by any operator."

Jumbo One-man Placer Machine is a product of the present depression, having been designed for use by the man of small means, enabling him to extract the values at an extremely low cost—about 50 cents per day for gasoline and oil to run the engine.

"The machine consists of a revolving conical shaped drum with a heavy grid screen in the center, six inches wide, over which is placed a finer mesh screen. The fineness of the outer screen is determined by the fineness of the gold or other metal content which it is desired to extract. The action of the sand and gravel revolving in the drum has a tendency to scour the gold, preparing it for quick amalgamation. The fines pass into the hopper and are then passed over an amalgamator or small concentrator, or both, as may be required. One man can put through the machine from ten to fifteen yards of gravel per day, depending upon his ability to shovel and the condition of the deposit. Gravel running as low as 50 cents per yard will pay him good wages.



Jumbo One-man Placer Machine.

"One distinct advantage is the comparatively small amount of water required when treating damp or wet material. It can also be used dry, providing the material is perfectly dry.

"Numerous mine dumps contain 'fines' which contain good values, and which can be treated with this machine at a very nominal cost.

"The machine is entirely portable, mounted on wheels, and can be dismantled so that the heaviest part will weigh less than two hundred pounds.

"No extravagant claims are made for this machine, and it requires only a good day's work on the part of the operator and the values in a wide range of material. The machine is simple and can be handled by any operator."

Kellogg Black Sand Machine. This machine has been described by both Logan and Haley. Logan, in describing the method of recovering platinum from black sand obtained in dredge operations in the Oroville district, says:

> "Some of the clean-up men at Oroville have made use of the Kellogg black-sand machine to recover the platinum from the long-tom concentrate. In principle, this device is an inverted funnel with pockets around the circumference. The sand and water are poured down the sides and the concentration is brought about by the boiling action when the mixture flows into the pockets. This gives a very rich concentrate about 50% metal. The machine appears to be a good saving device. A recent clean-up made with it gave 4¾ ounces platinum. The residual black sand from the clean-up was treated chemically and was found to contain 90 grains of platinum. This would indicate a recovery of slightly over 95% with the appliance."

The manufacturer of the Kellogg machine is not known.

Kimball Concentrator. A machine wherein centrifugal and hydraulic forces are operated under control and whereby practically 100% of all free metal of high specific gravity is recovered from the sand of placer or quartz mill operations, black sand particularly, regardless of the fineness thereof.

> "A standard size machine has a capacity of from 5 to 10 tons an hour, depending on the fineness of material and nature of metal recovered, and requires from 3 to 5 horsepower to operate, and water from 20 to 25 gallons per minute per ton of sand per hour.
>
> "Machines may be installed singly or in batteries if larger output is required.
>
> "Action of machine is nearly automatic, no skilled labor is required and one operator can handle five machines as well as one.
>
> "In addition to the larger metallic particles, the Kimball Concentrator recovers the fine and microscopic values which in other operations pass over and are lost from sluice boxes, canvas plants, concentrating tables, jig concentrators, vanners, etc. Reduces volume 50 to 1, or 100 to 1, if desired.
>
> "Installation cost is about one-tenth that of flotations, cyanide or concentrating table plant handling the same amount of material.
>
> "One machine will do the work of six concentrating tables and accompanying vanners, and requires only a floor space 6′ by 8′, head room of 7 feet, and an inexpensive foundation.
>
> "The following is a report from the D. M. Wood Laboratories indicating the fineness of gold that has been recovered by this machine:
>
> Certified Chemist
> American Board of Shipping
>
> Affiliated with
> Porro Biological Laboratories
>
> D. M. WOOD LABORATORIES
> CERTIFIED CHEMICAL ANALYSES
> 517–518 Provident Building
> Tacoma, Washington, December 18, 1929.
>
> "MR. S. C. KIMBALL,
> Tacoma, Washington.
>
> "DEAR SIR: We have examined the sample of concentrate which was submitted as obtained by the user of your concentrating machine from sand at the Butler-Qumalt Mine.
>
> "This material was examined microscopically, using various magnifications, from 250 to 1200 diameters. We found numerous small particles of gold and platinum in this concentrate, all too small to be seen by the naked eye, in fact the majority were too small to be seen under 250 diameters.
>
> "The sample submitted was too small to attempt any assay of the material so no idea could be obtained of the actual value of the sample.
>
> D. M. Wood Laboratories,
> (Signed) D. M. WOOD."

Mr. Kimball now resides in California and the machine is manufactured here.

Klondike Gold Concentrator. No details are available. Manufactured in Los Angeles, California.

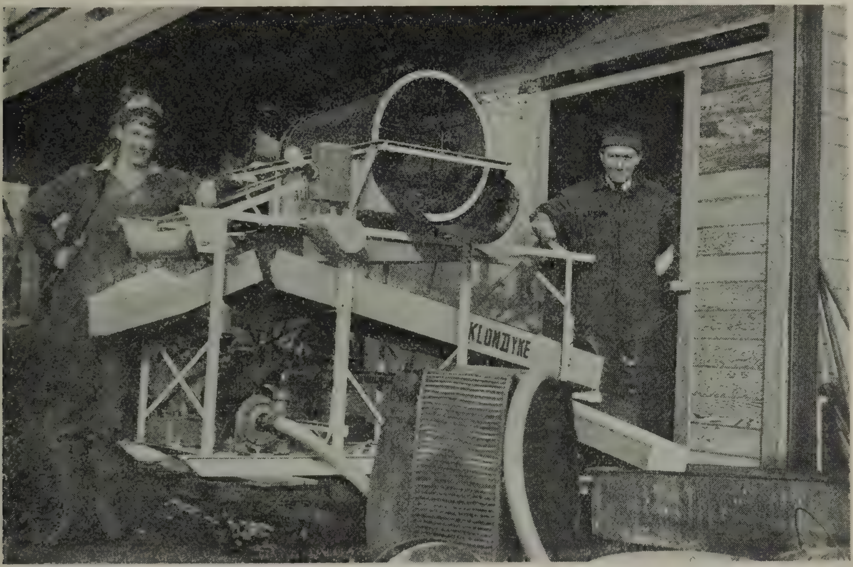
Klondyke Machine. The construction of the machine (Model A) is shown by the accompanying cut.

> Models A and B have twin rotary sponge rubber riffle belts with flanges on each side and no shut down is necessary to clean up, as the rotary riffle cleans up itself.
>
> "Model A: 2-h.p. gasoline engine, 2″ pump, 6″ x 24″ rotary magnet, 2–12″ rotary riffles, 1–110 v. geenrator, 6–60 w. electric lights, weight 584 pounds. All metal, price $850 f.o.b.
>
> "Models B and C are smaller units and sell for $675 and $375 respectively."

Koloro Placer Mining Machine[1] is a wet placer machine designed and built on the principle of the dry washer, using a diaphragm to force water through a riffle table where in a dry machine a bellows forces air through the table. In the construction of the machine the designer developed it with the idea of the ability of the machine to handle yardage, the mobility of the outfit and the placing of the completed product in a price class that would make it available to even the most modestly financed of prospectors and developers.

"Powered by a two-horsepower gasoline engine which furnishes power to the diaphragm and the pump on the machine, the Koloro is capable of handling 50 to 70 cubic yards of gold bearing gravel in an eight hour shift. The yardage is dependent upon the condition of the material handled—that is, the number of boulders or the amount of clay or other gangue that would tend to impede the quick handling of the material into the machine or its passage through the machine.

"The Koloro weighs 550 pounds completely equipped and is movable on the traction wheels which are placed in the dead center of the machine. Little or no lifting is required for the machine balances upon the wheels and needs only pulling or pushing to move it. A lighter type of the Koloro having all the advantages of the present one is now being developed wherein a lighter engine and an aluminum frame are used and which complete will weigh approximately 350 pounds and is thus more adaptable for movement into inaccessible mountainous districts or transportation by air.



Klondyke Placer Machine.

"Gold-bearing gravel is handled in the Koloro in the following manner: The material is fed into a hopper by hand shoveling, conveyor or from a bin which can be fed by a power shovel. From the hopper the material passes into a revolving screen of a half-inch mesh. In both the screen and the hopper a powerful stream of water is sprayed on the material from a $1\frac{1}{4}$-inch pump. The material is thoroughly soaked in the hopper, and in the screen is tossed around continually under a spray which thoroughly disintegrates it even when the material contains a reasonably high clay content. The material over one-half inch is thrown through an opening to one side. The rest of the material passes the screen onto a spout and to the riffle board or table.

"The riffle table is actually the top part of a bellows which contains water fed through regulating a valve from the pump. The bottom of the table or the top of the bellows is made of a finer screen covered with a blanket and the riffles are placed on top of the blanket. A diaphragm is worked by an eccentric from the engine at the bottom of the bellows forcing the water through the screen and blanket, thus constantly agitating the material in a circular motion. Combination of the agitation and the slope of the table causes the material to quickly pass along the table, the gold piling against the riffles and the tailings passing over the end. The riffle table is removable by unscrewing four thumb screws and the gold is thus removed. After a month or more of use the blanket can be removed and a new blanket substituted, the old one burned and a great deal of very fine gold, otherwise lost, will be found in it."

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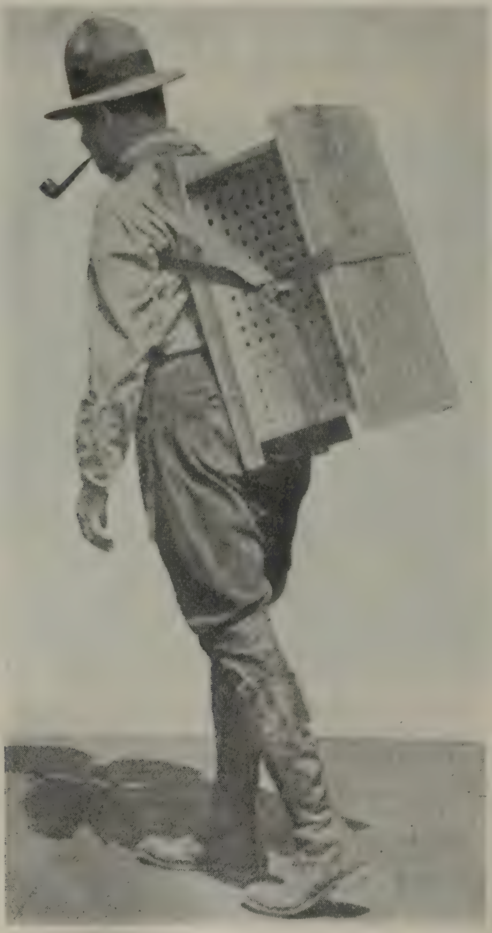
[1] Described and illustrated in The Mining Journal, Phoenix, Ariz., May 15, 1933.

Larson's Portable Rocker with Rubber Rifle-Barrel Sluice.

"The rocker is made of high-grade steel heavily galvanized. Equipped with screen tray 12 by 14 inches by 3 inches deep, and perforated with holes ½ inch in diameter.

"Sluice—rubber rifle barrel principle—a new and effective method designed with riffles ⅜ inch deep, running lengthwise of the sluice with rifle principle ridges ⅝ inch moulded crosswise at an angle to produce a natural swirling semicentrifugal motion to the material in solution with water as delivered into the sluice from the rocker.



Larson's Portable Rocker.

"The sluice is so constructed that the upper portion of the inside of the barrel or sluice is smooth rubber when in position. The operator detaches the sluice from the rocker for 'clean-up', reverses the position of the sluice, dislodges the gold or black sands lodged in the riffles and readily removes it by washing it into a receptacle.

"It will be seen that all the gold particles lodged in the sluice can not get away, there can be no leak, and that if desirable to move before any clean-up is made, it is a simple matter to close up the discharge end of the sluice with a plug.

"As the 'Rifle Barrel' sluice is of flexible rubber it may be adjusted readily to the pitch or angle best suited to the type of material handled. Furthermore, if handling light gold or fine grains or flakes a second section of the 'Rifle Barrel' sluice may readily be added, giving a total length of 7 ft.—or a small section of carpet or blanket may be used at the discharge end for particularly light gold.

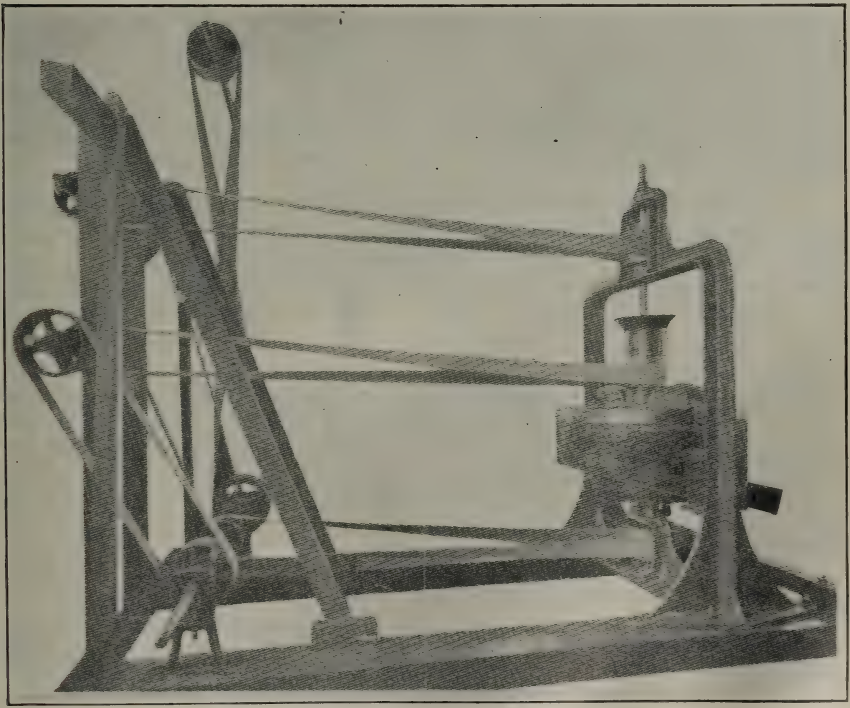
"Portability—This construction of rocker and sluice offers the maximum of portability in that the total weight of less than 30 lbs. can be readily and easily carried anywhere by shoulder straps as a pack on one's back or be conveniently carried in the hand.

"One's output can be multiplied up to 20 times the amount handled by panning, depending upon the type of material worked.

"Recommended for small placers, stream beds, tailing dumps, black sand deposits in any location where there is a sufficient water supply to properly liquefy or wash such deposits. Where water is scarce, the water may be successfully impounded and used over and over."

Leupold Dry Recovery Process. This is also a dry extraction method for placer gold and platinum. Developed in Canada. The inventor is looking for a place to operate in California. No description of this process is available to the writer.

Lincoln Flour Gold Concentrator. The company states that they have perfected and patented a new concentrator for handling flour gold, which has been tested and proved to do all that is claimed. The machine is to be manufactured in sizes to meet the needs of the small single operator as well as those of the largest dredges. Further information may be obtained from the manufacturers.



Logan Centrifugal Gold Extracting Machine.

Little Wonder Machine. Handles about 1 cu. ft. of dirt in 7 minutes and is stated to recover 95% of values.

Logan Centrifugal Gold Extracting Machine. This machine, patented in 1926, is designed to save fine gold without the aid of quicksilver. It is claimed that it will make practically a 100% recovery of gold even when so fine that it will float on water. Testimonials of men who have seen the machine under actual working conditions are submitted. Most of the tests were made on gold-bearing earth in Georgia and Virginia, the machine being manufactured in the East. It is said to have a capacity of approximately 50 tons per day and is intended for placer mining, stream shovel operating, dredging, free-milling ore, old dumps that have been passed over amalgam plates, or for any conditions in which the gold can be liberated from foreign substances.

Logan Pocketed Gold Pan. An active man can pan four or five times as much material in a day with this new pocketed pan as he can with the old styled pan, and get larger recoveries of fine-flour gold in each one than is possible to save in the old fashioned panning methods. It is also efficient for cleaning up mill work, and recovering fine-flour gold in the black sands.

"To operate the pan, fill in about one-third to one-half of material, it will be much faster than to put more material in at one time, for the reason that you can settle the gold to the bottom of the pan quickly which is the first important operation. If the water is so that you can keep the pan submerged it works best—turn your pan so as to wash the gold down in the corner of the pan in front of the center of the largest pocket; keep operating and tilting the bottom of the pan upward, thus sliding the gold into the center of the pocket, and the waste sludge will wash over the top of the pocket at once, then level the pan again and repeat the operation of the reduced wash to the center or intermediate pocket which is quickly done, then level your pan again and turn to the third or small concentrating pocket. As this pocket is much reduced in size, it will require a little caution by the operator, but by this time your wash will be clear and the operation visible. You can then wash the concentrates into a clean-up receptacle through the open side of the pan.

"The whole thing is quickly done, and after you have concentrated fifteen or twenty pans and made a general clean-up, you will be surprised at the time employed, and quantity of recoveries obtained over the old-fashioned panning system on an equal amount of material."

This company also manufactures a *3-man placer mining outfit* which consists of one well or prospecting auger that will bore a hole from 8 inches up to 14 inches in diameter to a depth of 25 feet. Four 5-foot extension rods accompany this auger. This auger is valuable for locating placer ground to good depth or boring wells with little work.

"One scouring machine, capacity 1½ to 2 cubic feet in each batch. This machine is reversible; first fill from one side, then tip it over and scour and dump on the other.

"Two wheelbarrows, one to supply the scouring machine, and the other to dump into and be used as a supply vat for the panners to fill their pans from.

"One rake to rake the cobbles out of the sludge to avoid loading the pans with unnecessary and surplus material.

"Three shovels and three picks for general use.

"Three Logan Pocketed Gold Miner's Pans with three graded pockets each that reduce the wash from one to the other down to close concentrates.

"Two buckets, one to receive concentrates from the pans, the other one to supply the scouring machine with water.

"One tub for general use and especially where the water supply is limited.

"This equipment is substantial, and will give long continued service. Mining can be carried on in quite cold weather because the material is not handled with the hands.

"Three men can do a profitable business where there is any gold worth while, one man to operate the washing and scouring machine (or it can be operated with a one-horse power engine also) and two men to pan with those efficient pocketed mining pans.

"The entire equipment can be hauled in a light Ford truck and be put in actual operation in a few minutes."

Lorentsen Centrifugal Fine Gold Recovery Machine. This apparatus is described in Engineering and Mining Journal[1] as a machine that utilizes centrifugal force, successfully it is said, in amalgamating free gold ores, placer sands, concentrates from sluice boxes, and so-called black or magnetic sands. The machine which is patented is called the Lorentsen centrifugal fine-gold recovery machine.[1] According to the company it is made in various sizes, is ruggedly built, and can be easily handled. The size with which the company has had the most field experience handles 1 cu. yd. of concentrate (averaging 4300 lb.) per hour, and requires a little less than 2-h.p. to operate, the friction being slight owing to the use of ball bearings.

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[1] Amalgamating Gold Ores and Sands With Aid of Centrifugal Force, Engineer and Mining Journal, September 14, 1931.

> "Essentially, the device consists of a bowl mounted in a casing, and rotatable at any desired speed. To operate it, mercury is placed in the bottom of the bowl, which is then rotated until the mercury spreads out over the inside through the action of centrifugal force. The sands or other materials to be treated are then introduced with water into the feed pipe of a centrifugal pump, which is specially arranged so as to deliver the pulp from the bottom of the bowl in such a manner that its angular velocity exceeds that of the bowl. This facilitates its distribution evenly on the surface of the quicksilver. Attached to the feed pipe are four arms that revolve with the pump and at equal speed. To these, in turn, are attached flexible devices which, as the machine revolves, throw out blades which travel parallel to the mercury wall and close to it, thus serving to agitate the materials as they travel upward toward the edge of the bowl.
>
> "Under the action of the centrifugal force, the component parts of the sands treated tend to separate, the heavier particles moving to the outside, where they penetrate the mercury and are held against the wall of the bowl. Clean gold is quickly amalgamated and rusty or greasy gold (and platinum) is retained against the wall until the rotation ceases. The sand or other material, of lesser specific gravity than that of mercury, passes over the surface and out over the edge of the bowl. When the machine is brought to rest, the quicksilver is scooped out, strained and retorted in the customary manner. A machine such as this, capable of handling 1 cu. yd. of concentrate or 2 or 3 tons of milling ore per hour, will require about 50 gal. of water per minute, which will also suffice for removing the tailing. If water is scarce, some method for circulating it can readily be devised. According to the company, the machine has been tried out under exacting conditions on beach-sand concentrate of Graham Island in the Queen Charlotte Group, British Columbia. Difficulties were great, the camp being two days away from any source of supply. The machine used (1 cu. yd. of sand per hour) has handled approximately 1000 cu. yd. of concentrate and has made continuous runs, it is said, under critical examination. In a month's trial it made a recovery of 93%, and since then has done substantially better, owing to improvements made. R. G. Mellin is quoted as reporting that out of twelve samples of tailings taken and assayed, the returns from one gave a trace of gold and the remaining eleven showed none. On treating sand around Martell Creek an average recovery of $2.11 per cu. yd. in gold was made out of a total of $2.25 per yard.
>
> "Loss of quicksilver was practically nil, native quicksilver being said to be recovered in the course of operation. In experiments on a smaller scale, the company says it has handled almost every kind of crushed ore containing free gold, including talcy ores. The machine has been found to do exceptionally good work in amalgamating gold from 16-mesh and under."

Macartney Amalgamation and Concentration Machine. This machine has a large capacity, handling approximately 500 tons of gravel per day in place, placer; ground ores, 150 tons per day, with recovery of about 95% in both cases.

The machine weighs 1200 pounds and requires 5 h.p. to operate. The 75 pounds of mercury in the amalgamation section is electrically charged from a generator operating on the machine. It requires from 15 to 20 minutes to make a clean-up. The concentrator discharges automatically.

Macartney Dry Concentrator is a perfected dry machine which works solely by intermittent air pulsation. The riffles are diagonally placed, the table is self-clearing and cleaning, and one table will handle from 60 to 100 tons per 24 hours. This table has been thoroughly tested in the field and is said to be an absolute commercial success.

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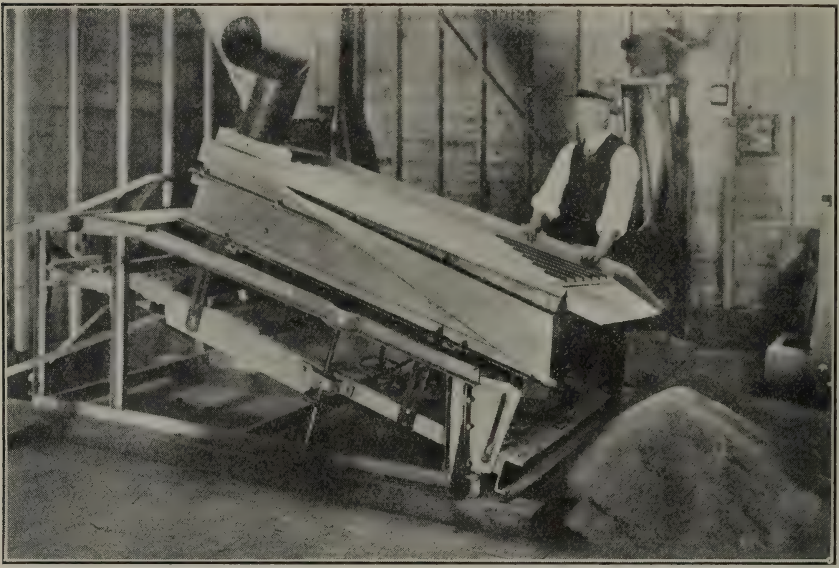
[1] Described also in The Mining Journal, Phoenix, Arizona, April 15, 1933.

In a test run made by Abbot A. Hanks, Inc., this firm states in their report as follows:

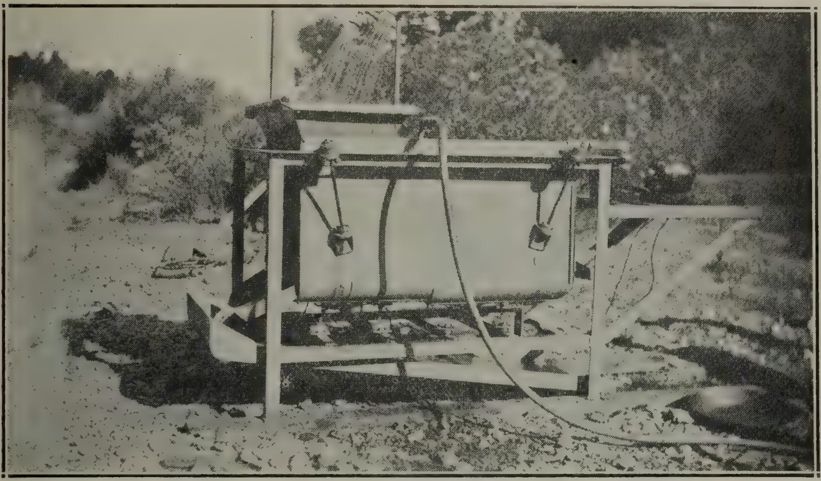
> * * * "Figured back against the original ton of gravel, the value recovered in the concentrate indicates that the gravel used in this test is worth $2.18 per ton.
>
> "As stated above, the entire tailing from the test was carefully sampled and a sample of some 60 pounds taken to our laboratory for assay. Special assays were made on this tailing in duplicate. These checked exactly and showed a gold value remaining in the tailing of 6/10 of 1 cent per ton of tailing." * * *



Macartney Dry Concentrator.

This machine it is claimed will successfully concentrate platinum, gold, tungsten or any other materials that have a reasonable amount of specific gravity.

Mantell Placer Concentrator. The principal of the Mantell machine closely follows that of the miner's pan. The construction and operation are shown in the cut. The photo shows one without the feeding and screening portion, used in a test held on Wildcat Creek 10 miles east of Oakdale. The double panning section is suspended on hangers and motion imparted by an eccentric. The bottoms of the pans are made of rubber fabric to each of which is attached four metal disks with stems which rest on cross members. When in operation this gives an undulating motion to the bottom, alternately opening and closing cracks in the heavy black sand and permitting any fine gold or platinum to work to the concentrate drawoff. But little power is required and a half-inch pipe will furnish sufficient water for operation. The manufacturers recommend a separate engine and generator unit with individual motors on the machine and to operate a water pump as the most flexible arrangement, rather than a gas engine direct connected to the machine.



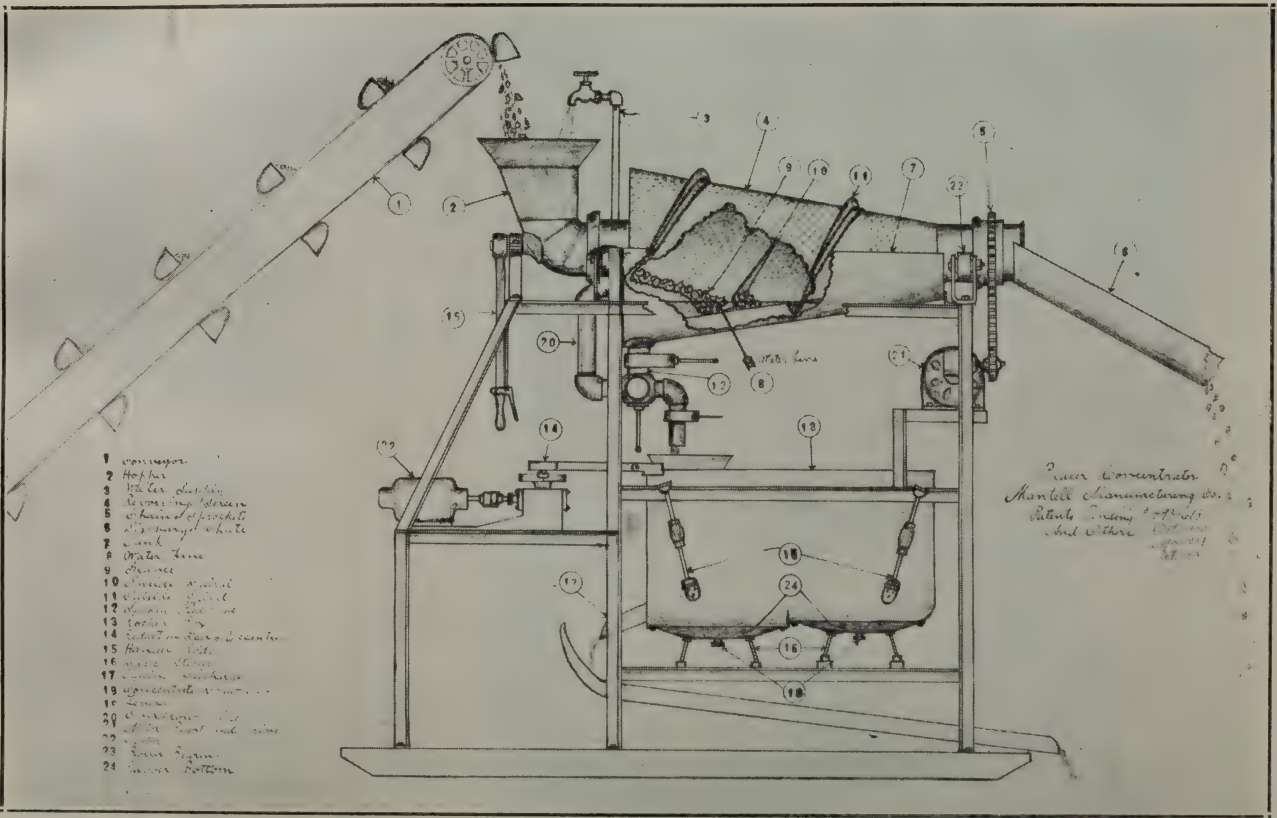
Mantell Concentrator being tested on Wildcat Creek.

Marmac Concentrator. This machine is illustrated and described by Frank P. Marugg in the *Mining Journal,* Phoenix, Ariz., June 30, 1933, issue. It is built on the old fashioned rocker principle which is combined with a specially designed riffle, similar to those used in the ordinary sluice boxes.

> "A series of traps, from which a clean-up of the entire machine can be made in 10 minutes, was added, and the machine equipped with power to replace the slow, laborious water dipping and hand-rocking method. This has made possible the offering to those interested in placer mining, whether on a small or large scale, a machine so simple in its construction and so sturdily built as to give years of service—all at a price that is consistent with its capacity and efficiency as a mining machine.
>
> "The placer material is introduced into a conditioner, which has a nugget trap and separate clean-out. In this compartment the clay, cemented materials, rocks and gravel are thoroughly scrubbed, then eliminated over a classifying screen." The remaining fine values enter the concentrator, which consists of a series of traps and riffles which gather and hold the values, allowing the tailings to escape.
>
> "All water is used over and over before leaving the machine, thus giving the effect of a long sluice, and at the same time keeping the traps open to receive the minute particles of gold. The oscillating motion assists gravity in eliminating from the machine its waste materials speedily, thus giving a very large capacity. A minimum of water and horsepower are required."

This machine in operation on Little Dry Creek, five miles southeast of Denver, is reported to be making a high recovery of the fine and flake gold, taking it out of a heavy clay and conglomerate formation, without the use of reagents.

Marsh Electric-Magnetic Separator. An electric-magnetic separator which works under water and with which it is claimed all fine gold can be completely separated from black sand.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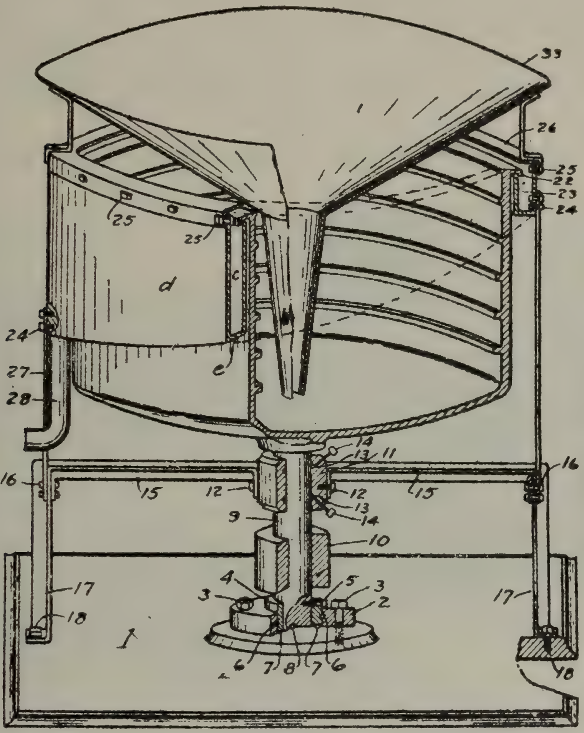
Water line
1 Conveyor
2 Hopper
4 Revolving Screen
5 Chain & Sprockets
6 Discharge chute
7 Tank
8 Water Line
24 Bottom
Placer Concentrator
Mantell Manufacturing Co.
Patents Pending
And Others

Mantell Placer Concentrator, showing screening section attached.

Matrix Amalgamator. This device, of the bowl type, according to a circular issued by the inventors, Geo. E. Banks and Harold N. Banks, will recover free gold and platinum from placers and shattered ores, whether rusty, greasy, floating or other kind.



Matrix Amalgamator.

In placer operations the coarse material, larger than a pea, is screened away allowing only the fine material that carries the values to enter the bowl, which greatly increases the earning power.

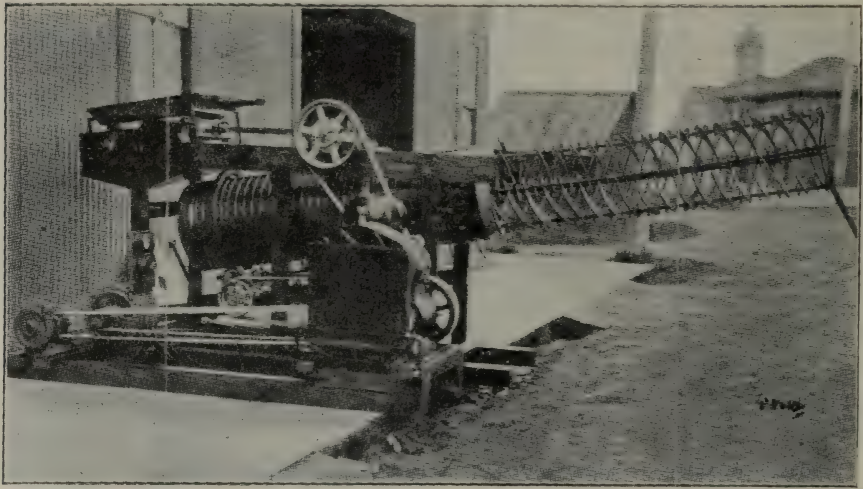
In milling work the amalgamators assume the places of tables and plates. They are built in two sizes with capacity of one and two tons of fine material per hour. Power required one and two horsepower. Mercury five and ten pounds for each charge. They are claimed to have been successfully demonstrated and operated on placers in Utah, Nevada and Washington, on the black sands of British Columbia and on the Oregon coast.

Maynard's Flour Gold Concentrating Equipment. This party has a special system and equipment for recovering flour gold, which he claims is highly efficient. No details concerning this process are known to the writer. It is probably home made.

McBride Cylinder Amalgamator and Process. The apparatus consists of a cylinder made of wood, mounted within two circular rails, which in turn roll upon trunnion bearings. Inside lining and cylinder is the plate.

"Resting upon the plate is a helical 'fin flight' assembly, made of semi-vulcanized rubber, staggered, being interrupted at each quadrant. This spiral fin assembly suggests that which is found in an Aikens classifier. The plate, the spiral fin assembly and cylinder rotate as a unit. The fins extend upwards from the plate a few inches, varying with the size of the cylinder. There remains, therefore, a considerable open cylindrical space, within the spiral fin assembly. Suspended within at the lowest point, just clearing the upper edges of the fins, is a carbon electrode (the anode). It is stationary and does not revolve with the cylinder plate and spiral fin assembly which revolves as a whole upon the trunnion supports. When mounted the cylinder is set so that the intake end is lower than the discharge end. Also the fins gradually diminish in height from the intake end as one progresses towards the discharge end.

"The process is the application of several well-known and long-established principles and actions, so arranged and coordinated as to make use of each step in proper and useful sequence and virtually getting into step with the operation of natural law and avoiding violent opposition thereto.



McBride Cylinder Amalgamator, showing fin assembly ready to be placed in cylinder.

"The outstanding feature is providing an amalgamating plate, the mercury on which is continually being supplied with sodium, so that on it at all times is a very active sodium amalgam.

"It is accomplished in this manner: the gangue of say 20% solids is introduced into the lower end of the cylinder which is closed except for a circular aperture in the center of the cover closing the lower end of the cylinder. The gangue enters by means of a simple launder. The water has salt added to it before it enters the cylinder. Sea water has been used very successfully. Now, when the pulp has entered the cylinder, the spiral fin assembly very effectively but gently rolls it progressively forward up the grade. A current of d. c. electricity is introduced, and passes from the carbon anode, through the pulp, to the plate underneath. The plate serves as the cathode.

"The current decomposes the sodium chloride, and sodium and chlorine results. The sodium presumably becomes sodium hydrate in most instances and as such or sodium, passes promptly to the plate. But when it strikes the plate, the hydrogen is released, and sodium metallic is formed and it having so slight a specific gravity virtually 'pops out' again and in coming in contact with the water forms sodium hydroxide (caustic soda).

"Where there is even considerable oil or grease present the caustic soda is quite sufficient to promptly saponify it, and in cases of certain oxides and other substances coating gold the inventor claims to have found the action prompt and effective in cleansing the metal for ready amalgamation. The chlorine escapes mostly as gas, for its odor is marked when the machine is in operation. Yet, considering the well-known tendency of chlorine for recombination it possibly serves usefully in other ways. In thinking of the chlorine, it should be borne in mind that the operating temperature of the process is a low one being that of the water supply.

"The effect of a current of electricity upon tiny particles of gold, silver or platinum is not clearly understood by many. Nevertheless, we have learned that it does serve very positively, effectively and usefully when applied with understanding.

"The physical action supplied by the spiral fin assembly can be only compared with skillful panning. The cylinder, revolving slowly, provides a gentle rolling motion to the pulp, avoiding sliding, and yet classifying sufficiently that every particle is exposed to the amalgamating plate long before it reaches the discharge end. Therefore, the presence of black sand or magnetic ore offers no difficulty whatever, but on the contrary seems to assist in the useful distribution of the electrical current.

"Under drastic test conditions it has been determined that 80% of the extraction is effected in the first 25% of the apparatus, or saying it differently, 80% of the metal extracted is recovered on the first quarter of the plate.

"Operating upon fine sands, semi-concentrates or concentrates, competent engineers are stated to have accorded the process the extraction efficiency of 99%, while the inventor claims 95%. It is understood that we claim this efficiency on free metallics.

"The successfulness of its action is based principally on destroying surface tension. The very reason mercury flours so readily is due to the fact that because of its density and surface character, it provides for pronounced surface tension. The tiny speck of gold, even though of much greater specific gravity, does not enter the mercury when in contact with it because the surface tension of the mercury does not permit it. The phenomenon is like that of the needle floating on water. Besides the surface tension affects the particles of gold and silver and even more so, the platinum.

"Two sizes of apparatus have been developed. One is portable to the extent that it can readily be taken apart so that it can be packed on burros.

"It has a capacity of not less than 1½ tons of fines or concentrates per hour. The cylinder is 18 inches in diameter and is 6 feet long. Additional equipment consists of a small d. c. generator, circulating pump for water, and a 4- or 5-h.p. gasoline engine. The size deemed most practical for large-scale operation, is 3 feet in diameter and 12 feet long. This size is the unit for battery installations. Its capacity is 15 tons per hour.

"The smaller cylinder complete will weigh about 600 pounds. The larger one will weigh under 3000 pounds.

"The items of cost of operation are power and salt. Under test conditions 3 h.p. revolved the large cylinder and supplied the needed electrical current. Salt consumption will vary from 3 ounces to 1 pound per ton of solids, depending on dewatering efficiency applied to pulp after treatment. There are so few moving parts and they are so simple that wear is slow."

McBride Hand Placer Rig. McBride also has a hand placer rig. Each machine is stated to be capable of supporting three men on fair gravel. It uses the water over and over so is suitable for desert conditions. Capacity, one ton an hour.

McBride Placer Rig.

McLeod Gold Saving Machine. Nothing is known regarding this machine except the name and address of the Seattle party who has it.

McMillan Placer Apparatus. Mr. McMillan has designed a mobile placer mining and gold-recovery plant for installation at a deposit in Trinity County. The equipment consists essentially of a power-shovel mounted on caterpillar trucks which delivers the gravel by means of a conveyor to a trailer carrying the screening, washing, gold-saving equipment and stacker for tailings.

Meade Machine. An electrical amalgamation machine. Capacity about 10 tons per hour. Is described and illustrated in the *Los Angeles Times,* September 18, 1932, issue.

Mechanical Gold Extracting Machine. This machine is stated to have a capacity of 25 tons per day and to be 99% efficient in recovery, including flour gold. Further details will have to be obtained from the manufacturer.

Mechanical Panner and Clean-up Machine.

> "The portable placer washer and clean-up machine is the only machine using a complete oscillating and kick motion. It is the smallest big-placer-washer that can really handle yardage when properly rigged up. It saves practically all the gold in ordinary placer gravel, reduces the concentrate to the minimum, saving the large expense in smelting costs and a tremendous amount of time in the cleaning-up process.
>
> "It is now being used successfully in conjunction with drilling and testing operations because it eliminates all losses from panning, the use of the rocker entirely, and speeds up the panning and clean-up operation to the minimum. It can be used to the best advantage also in arid regions by the addition of a settling tank to catch and filter the water, then repumped to the machine. A 100-gallon tank full is a sufficient amount of water for a day's run.
>
> "The machine in design is similar to a set of four bowls or gold pans. The sand and tailings that are fed into it are sloughed off the sides of each pan by the constant agitation and continual flow of water until they have reached the last trough which runs off the tailings from the bowls and away from the machine. With a sufficient head of water, you can with riffles in your sluice, handle 2 to 3 yards an hour, using the under current as a feeder to the machine.

Mechanical Panner and Clean-up Machine.

> "The clean-up on the machine is made by shutting off the feed of material and with the water still running into the machine, the four or eight plugs that are within easy reach of the operator, are pulled out. This allows the concentrate to run out under the bowl through a chamber which is part of the bowl, into whatever receptacle is being used to catch the material and may be sent to the smelter as is, as it is clean commercial concentrate.
>
> "Quicksilver may be used if desired, thus amalgamating as well as concentrating at the same time. Engine requires a ¾ to 1 h.p. motor or gas.
>
> "The machine which is made in two sizes can be furnished with or without motor and pump. Complete rig-up instructions sent with order.

Mendenhall Gold Concentrator.[1] Another recently developed machine for concentrating gold-bearing gravels and sands. The prime objective is to save the fine gold, which it does successfully, according to the company. The device consists of a water tank, a screen, and a series of superimposed trays. By means of an oscillating action, the trays are caused to discharge off the highest points one into the other. Capacity is said to be 3 to 6 cu. yd. per hour. The machine weighs 1100 lbs., including a 1½-h.p. engine, and occupies a 4 x 8½-ft. space. It is said to use but little water.

Mexican Dry Washer. The typical Mexican dry washer, very well constructed. Made in Phoenix, Arizona.

Miller Metals Separator is another device for saving tailings values concerning which no details are at hand.

Mitchell Patented Sluice Box and Riffle. A new type sluice box and riffle board invented by H. C. Mitchell. The device is said to contain two outstanding features which none of the more than 7000 patents designed to save 'flour' gold in placer mining combine.

> "First, the machine is so constructed that it can handle volume unlimited, according to claims made for it.
>
> "Second, the screens in the sluice box run from a 1/32 of an inch to a fineness that water scarcely will pass through, and underneath the last screen is the riffle-board of wood, two inches thick. The slope, form and size of the riffle is the feature that saves the flour gold.
>
> "The riffle is a quarter of an inch deep at the upper end of the board and one and a half inches deep at the lower end. Its width tapers from top to bottom. The riffle also is undercut and the water whirls the gold and black sand in this undercut and finally passes it out at the lower end through an opening, regulated by slides, into a shallow trough.
>
> "The trough or 'launder' is lined with burlap or carpet, the nap of which catches the gold."

The device is claimed to be 98% efficient or far greater than any other sluice now operating.

Modern 49-er. This gold recovery machine is made in three sizes: ''Baby'' model, a light compact portable hand-operated separator that can be knocked down and packed in. Weight, 125 lbs. Capacity, what one man can shovel. ''Sniper'' Model, weight 250 lbs. Power, ¾-h.p. 4-cycle air-cooled engine using 2½ quarts of gasoline per 8 hours. 15-inch centrifugal bowl. Capacity, 1 to 3 yds. per hour. Master model, shipping weight 585 lbs. 4′-8″ long, 2′-1″ wide, 4′ high. Revolving trommel 16″ by 48″ with ¼″ mesh. Power 1½-h.p. air-cooled engine consuming 1 gallon of gasoline per 6 to 8 hours run. Twenty gallons per minute of water required.

Special advantages claimed for the Modern 49-er are:

> "Over 90% recovery of gold. Especially efficient with fine and flaky gold. Low economic cost per ton, for operation. Less water per ton of material handled, and water can be used repeatedly. Average weight less than 300 pounds and two men can lift and move anywhere. Can be dissembled and packed on horses; engine, heaviest unit, weighs 110 pounds. Very low gas consumption, easily operated, virtually no upkeep or repair problem. Adapted to all classes of placer mining, including black sand where values run more than 1500 colors to the cent. Ideal to reap hand-

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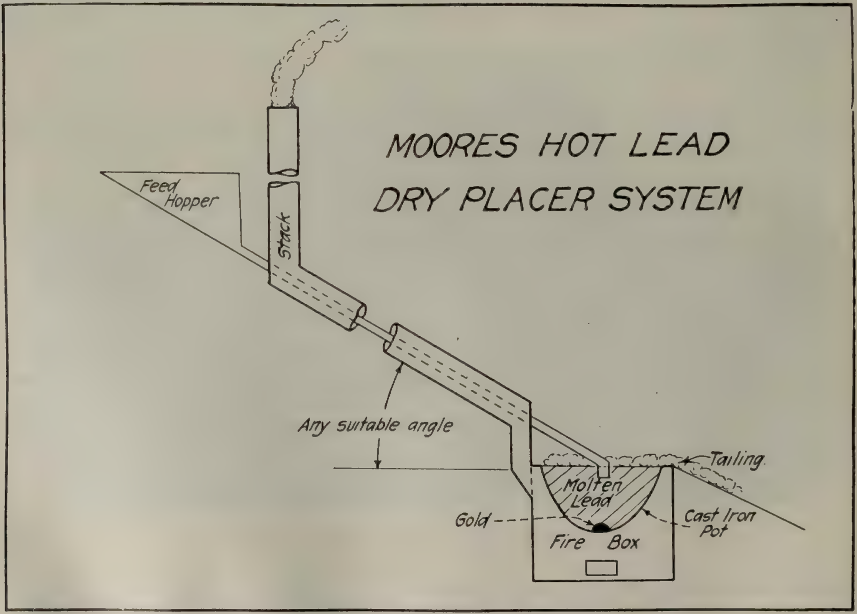
[1] Illustrated and described in Engineering and Mining Journal, April, 1933, p. 171.

some profit from many of the abandoned claims and gold ore dumps. Larger capacity, more thorough, speedier, and costs less than any other gold separators in approximate size or cost ranges."

"Baby" Model Modern '49er.

Moore's Hot Lead Dry Placer System. This scheme for recovering gold or platinum in localities where water is not available originated from watching a small boy toss an iron bolt into a pot of molten lead and noting that the iron floated. The basic idea is, that if gold-bearing sand and gravel is submerged in molten lead, the gold being heavier than lead will sink and the other material will float and may be raked


MOORES HOT LEAD
DRY PLACER SYSTEM
Feed Hopper
Stack
Any suitable angle
Tailing
Molten Lead
Gold
Cast Iron Pot
Fire Box

Moore's Hot Lead Dry Placer System.

or scraped from the surface. It is proposed to feed the material into the molten lead through a pipe which is surrounded by the flue from the firebox so the gravel will become as hot as possible before it enters the lead bath, thus conserving fuel.

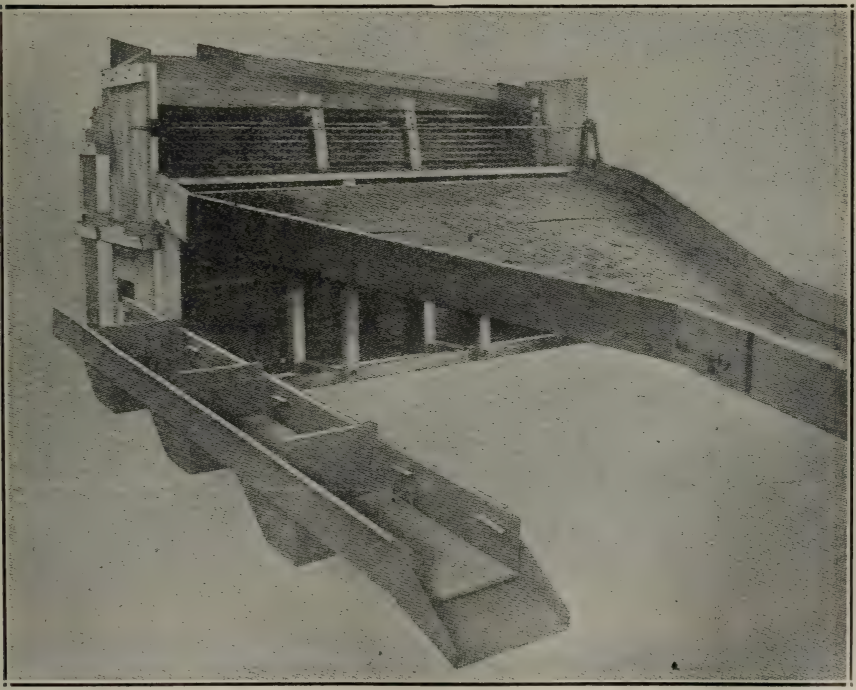
In an experiment Mr. Moore claims to have made a 100% recovery of filings from a gold coin mixed with sand and gravel and subjected to the treatment, stating that after cooling, the bottom of the lead mass was sawed off and all the gold reclaimed.

Any fuel may be used and if necessary a screw-conveyor or other means may be used to feed the material. The tailing may also be removed mechanically.

No particular form of construction is given but the sketch herewith will show the principles involved.

Assuming that the process itself is 100% perfect there are obvious reasons why it would only be applicable to very rich concentrations.

Moore's Suction Undercurrent System. Consists of a main sluice with one or more openings in the bottom covered with a perforated plate over a V-shaped box. These undercurrents have a strong suction effect, a whirlpool forming in the sluice over each one. It is claimed that any flake gold that may be floating on the water is tipped up on edge and sinks below the surface, when it reaches the vortex of the whirlpool. A series of any number of these suction undercurrents may be installed



Adjustable grizzly suitable for using undercurrent product over Mat-o-Gold equipment.

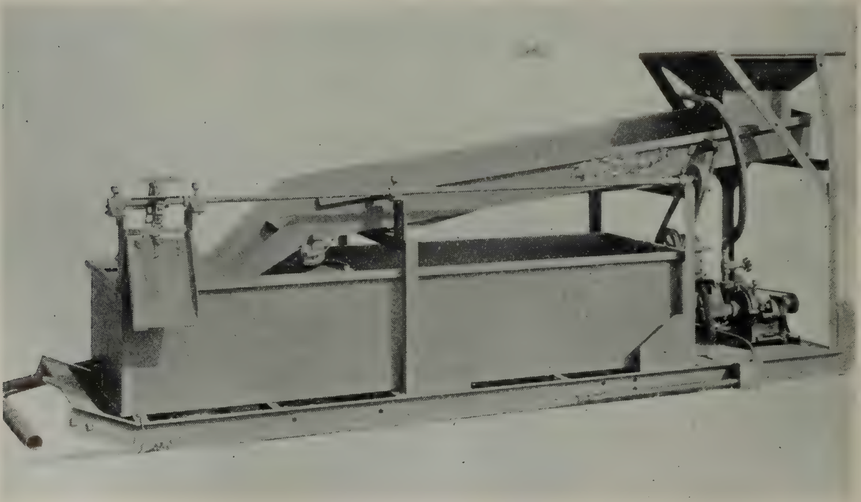
depending on the layout of the workings and amount of fall available. This system was used in Humboldt County at the Klamath River Mine by Mr. Moore.

Morgan's Patented Mat-o-Gold. The mat-o-gold is a rubber slab or mat of sponge-like, cellular construction, and is the basic idea around which various mining equipment is built by the Morgan Company. It has a multitude of resilient rubber cells that constantly vibrate while in use, and catch and hold the values, allowing the lighter particles to float away. It will not slime and has great wearing qualities.

It is further claimed that it forms a perfect riffle and positively will not pack, and is easy to clean without removing from position. All the defects and shortcomings of blankets, carpets, corduroy, canvas, cocoa mats, etc., are said to be overcome by this device.

This sponge rubber equipment has been used in the miner's pan, and rocker, in undercurrent boxes and sluices and as an endless belt on vanners, being adaptable to both placer mining and gold milling practice.

New Gold Recovery Unit. The type illustrated has a built-in circulation system whereby water is used over and over, tailings being discharged by a small chain drive at the end.



New Gold Recovery Unit.

"It has a capacity of 2½ to 3 (c/y) per hour, if material is screened to ¼-inch. In effect it is a glorified rocker in which there is a substitution for riffles of a special patented plate, the holes being ½-inch diameter on 1¼-inch centers. The plate itself being arched laterally and transversely and the plate edges affording a seal against the bottom of the box. There are two plates 2 feet each in length followed by two amalgam plates 2 feet long, each.

"The unit shown on photo is 18″ wide by 8 feet long. It is of all steel construction and with nominal care will not wear out.

"The vertical travel of the rocker is approximately 4″ and it rocks 40 times per minute. The water feed is a 1″ centrifugal pump, delivering 40 gallons per minute. Material reaches the head plate, passes over it to the secondary vortex plate whence it passes over 20 mesh screen, the fines dropping 1″ to the amalgam plates, thence being discharged into the sub tank, where all tails are packed up by the short tailing stacker and dragged out.

> "Reports from various owners state that the water loss is as low as 25 gals. per (c/y), but the only guide that a man may have for actual operation is the generality that the water loss is that of absorption.
>
> "All gold which can be seen with the naked eye (and unless it is coated which thereby lowers its specific gravity) stops in the first 12" of travel through the box, being caught under the vortex plate. This plate, we believe, creates top and bottom water currents, the plate itself being a lamination of steel between the two and the holes in it creating tiny whirls or boils.
>
> "The amalgam plates of course, function on fine gold as plates do anywhere.
>
> "Due to the rocker action, material has a linear travel of 24′ in the 8′ box. Light material will travel from 24 to 40 feet, the action being crossing and recrossing on the diagonal with the water.
>
> "It has few moving parts, it is simple in operation, with little or no replacement cost, due to all-steel construction, and it has a surprisingly high recovery factor, in some instances showing returns equal to those of dredger operations.
>
> "At the foot of the plates, there is a black sand or concentrator trap which discharges outside the machine to buckets or any kind of container but we advise that where the black sand is worth saving, the discharge be a small concentrating table for a clean separation."

New Type Suction Guns. This apparatus is designed for the purpose of cleaning out bedrock crevices under water. A combination of vacuum and compressed air is used.

Norvelle Wet and Dry Jigs. This wet jig has the entire cell submerged. The feed is forced down under a baffle plate at the head or feed end. The inventor claims advantages over the ordinary jig by reason of the fact that less force is required to suspend the gangue when submerged; also that the force of the pulsations is distributed uniformly over the bed and that the increased velocity at the discharge end is overcome. By a special arrangement of plungers on a crank shaft he obtains a maximum and minimum pressure from the impulses. In this manner the pulp is always suspended but the minimum pressure strokes allow settling. The water is in a closed circuit, the plungers furnishing the impulses also act as water return pumps.

The dry machine involves the same principal of maximum and minimum impulses of air. A steady flow of the pulp over the riffle board is maintained without the jerky vertical motion given to the pulp by a bellows. The air is supplied by two double-acting pistons, so fastened to a crank shaft that a maximum and minimum impulse is obtained.

Parker's Gold Trap Process. This device for extracting gold from sand and gravel in flowing streams, the invention of J. E. Parker, is being used on a commercial scale by the Parker Process Syndicate at their property on the Vermillion River, Montana.

A detailed description of the process with photos showing the arrangement and construction of the Parker Gold Trap is contained in the Mining Review of Salt Lake City [1] from which the following notes are reproduced:

> "The Parker Trap is an arrangement of riffles in the center and steps along the sides of a fan-shaped passage. The water pours into the narrower end of this trap with considerable velocity, which is then slowed down as the trap widens. Over the Hungarian riffles round planks were placed just far enough apart to permit the black sand and the smaller pebbles and nuggets to pass between them. Similar planks are placed across the steps beside the riffle at an oblique angle which causes the ends of the planks toward the center of the trap to point upstream at an angle of about thirty degrees. These halt the fine gold moving swiftly with the stream and propel it toward the center, where the backward suction into the riffles tends to cause still more gold to be deposited in the open spaces under the planks.
>
> "Recoveries are slight in the sets in the flume which were mainly to halt the flow of water, and set the gravel and nuggets which it contains to boiling and

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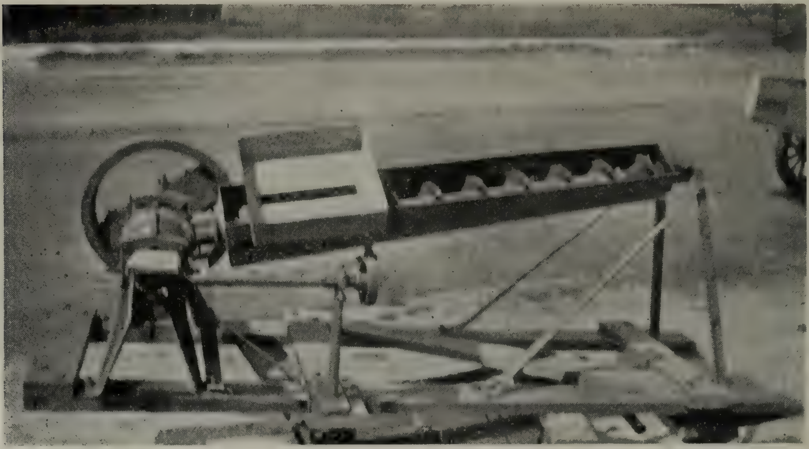
[1] The Mining Review, Salt Lake City, Utah, Vol. 30, No. 9, August 15, 1928.

settling. In the neck of the flume recoveries are a little higher, but the chief values are obtained in the pan, which is four feet across at the upstream end and about ten feet wide at the lower end. The highest gold recovery is and should be made in the second and third riffles from the lower end."

Paulson's Airless Dry or Wet Gold Washer. A new invention with a larger capacity for extracting gold and black sand from auriferous sands and gravels with or without the aid of water and mercury. These machines are made in different sizes which handle from 5 to 20 tons of gravel per hour, employing a power plant of from 1½ h.p. to 3 h.p. When used as a wet washer, from 15 to 20 gallons of water per minute is needed, but as this water can be reused, it is a practical machine where water is scarce. Through actual demonstration, it has been proved that from 75% to 100% of the gold is saved, whether it is fine, flour, flake or coarse gold. A recent test of ocean beach sands, without the use of mercury, gave a 75% clean up. It is also notable that this same sand contains 70% of black sand by volume, and the above machine saved all of it.



Paulson's Airless Dry or Wet Gold Washer.

"The operation of this machine may be described as follows: The pan is a half cylinder five feet long, about 12 inches deep at the receiving end, and tapering to 8″ deep at the tailings end. The top side of the cylinder, is open throughout its entire length, this opening being 8″ wide. This pan rocks on the axle of a conveyor screw. The rocking motion of the pan settles the gold and other heavy minerals to the bottom of the pan where it remains until removed through the clean-out. The tailings and waste material is continuously pushed forward by the conveyor screw until it is removed. To facilitate the conveyor screw in removing the waste, and to insure that lumps of dirt will be broken up and that soils will be removed from rocks, etc., the conveyor screw is armed with a series of spikes. These actually enlarge the capacity of the conveyor screw without inreasing its weight. All the gears of the machine are incased in a housing, such preventing damage due to spilled gravels, etc. The measurement over all of this machine is 36″ by 84″, its weight is 300 lbs., and it can be easily knocked down for transportation. Its construction is all steel throughout.

"The practical features of this machine are as follows: Gravels are agitated by the rotary motion of the conveyor screw. The gold is settled by the rocking motion of the pan. As much as sixty lbs. of concentrates may be allowed to accumulate in the pan before it is necessary to clean it out. The waste materials are automatically removed from the pan. The angle of the pan may be changed to satisfy the requirements of different situations. Gravel and rocky soils measuring to ¾″ mesh may be handled easily. It can be used without water."

Pierce Gold Separator and Amalgamator (The Gold Gatherer). The following general description of this device is taken from the catalog of The Mine and Smelter Supply Company.

"The Pierce gold separator and amalgamator consists of numerous L-shaped copper riffles, which are treated with quicksilver. These are so arranged that the water carrying the pulp or sand sweeps all particles repeatedly against the amalgamated surfaces. The L-shaped bottoms of the riffles also contain quicksilver into which rusty gold will sink by gravity.

"Riffles for placer mines and dredges, and for mills differ only in size. The principle and design are identical.

"The riffles are made of only the purest and softest, annealed, Lake Superior, or electrolytic copper. They are silver-plated, if desired. They are held in position by riffle-holders which are placed lengthwise of the riffle-box, and on each side of it. There are two sets of holders, one set for the lower riffles, and one for the upper riffles, the latter being placed on top of the former. The holders are grooved strips of wood, the ends of the riffles fitting into the grooves. The riffle-box is made of sheet-iron, and the joints are lapped and riveted to make it water-tight.

"The lower riffles (D), are bent somewhat like the letter Z. The top of each riffle is bent back in the direction of the flow of the water, thus allowing an air space to be formed behind the riffle. The bottom of each riffle is turned up at each end and brazed so as to hold a pool of quicksilver.

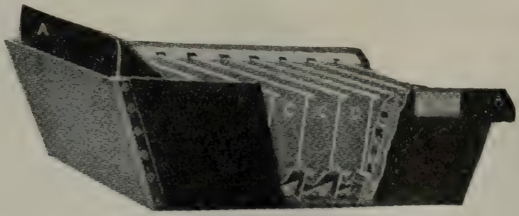
"The upper riffles (C), are placed above the lower riffles, and extended down between them. The tops of these riffles are also bent back in the direction of the flow of the water, while the bottoms are bent toward the flow of the water in such manner as to hold the quicksilver in the bend or L.

"The Pierce gold separator and amalgamator is characterized not only by successful design and excellence of material, but by the extreme care exercised in its construction.

"For placer installations one or more sets of V-shaped grizzleys are placed in the bottom of a section of the flume which is then set in the main flume or at the end of it. The bars of the grizzley are set at a slight angle from the flow of the water so that the fine gold, sand, and gravel are gradually brought to the openings and pass through them into the grizzley box. The grizzley box is supported by rods underneath the grizzley and flume. The bottom of the box slants downward in the direction of the flow of water. At the lower end there is a gate which can be regulated to take from the flume only as much water as is necessary to carry or move the gold, sand and gravel that pass through the grizzleys.

"The gold, sand and gravel are then taken in a launder, or flumes, to the screen boxes where the coarse gold and fine gravel are separated from the fine gold and sand. The latter pass through the screens which are adjusted by means of hand-screws so that the discharge end of the screen is higher than the end over which the gravel first passes. Underneath the screen a gate is provided which can be adjusted to admit only the amount of water and sand that the amalgamating boxes and riffles can handle. Thus the water is kept above the screens, expelling the air from beneath them, and the flow of the water carries the fine gravel and coarse gold over them. There is not the tendency for the coarse gold and gravel to settle and stop up the meshes of the screens as is the case where air is allowed underneath them.

"The riffle-box is set at an angle of from two to four inches to the foot, depending upon the material to be treated. The fine gold and sand pass through the screen and are then run through the riffles. The pulp flows underneath the upper riffles (C), and over the lower riffles (D). As it passes into the riffle box at (A), it fills to the top of the first upper riffle, and then passes under it and over the first lower riffle; then up between the first and second upper riffles to the top of them, where it looks like muddy water boiling; then down underneath the second upper riffle, up over the second lower riffle, up to the top of the second and third upper riffles, and so on until it passes out at the lower end of the box. The gold either adheres to the riffles or sinks into the pools of quicksilver. The sand and water are thrown out at (B).

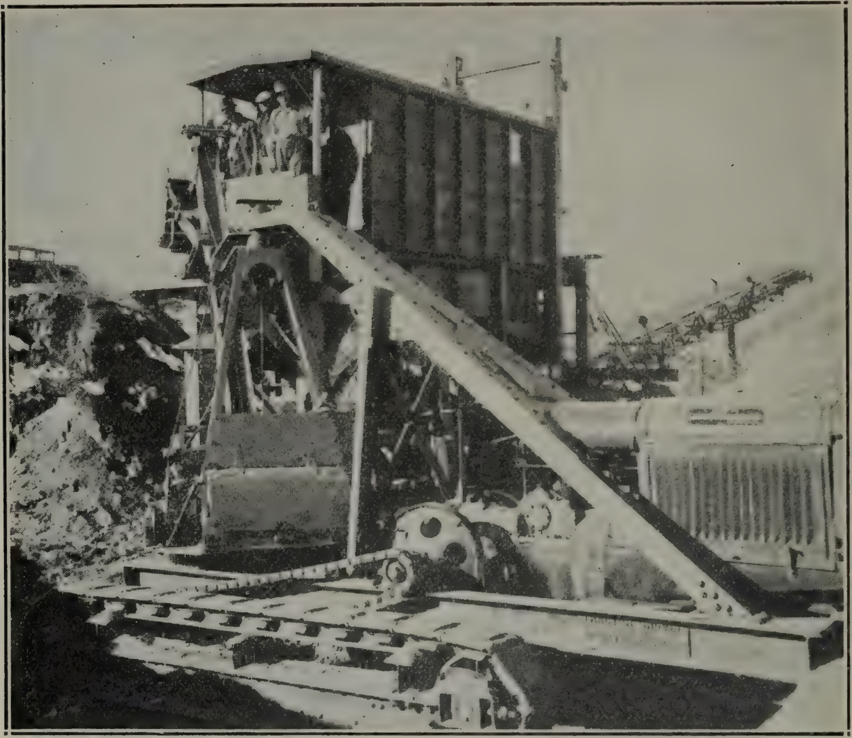


Pierce Amalgamator.

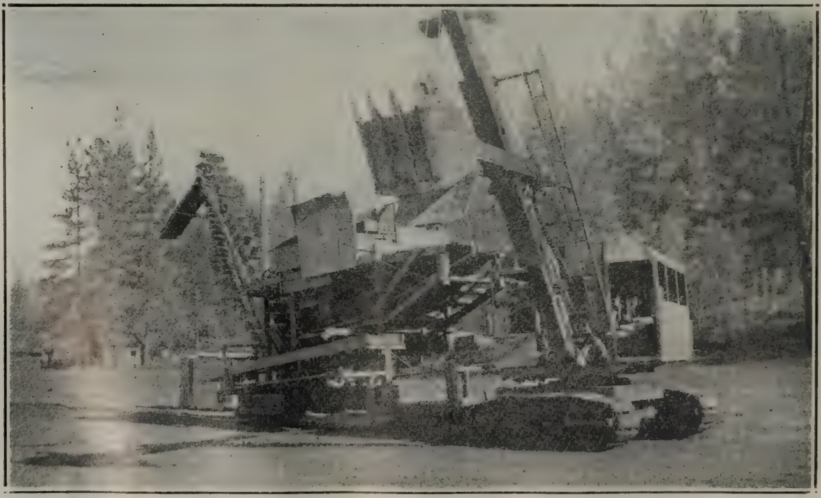
"The black sand is continuously agitated and thrown out by the water passing down between the lower riffles. And by keeping the fine, or flour gold in the current of the water it is swept against the amalgamated riffles so many times it is impossible for it to escape.

"As the coarse gold reaches the pools of quicksilver in the bottom of each of the upper and lower riffles it readily sinks into them, even though it be tarnished or fouled. This by reason of the fact that the specific gravity of gold is 5.8 points greater than that of quicksilver, in addition to the affinity of mercury for gold. Hence all of the gold lost in the ordinary riffle and on mill plates is retrieved in the Pierce."

Pierce Gold Dredge Machine. This machine as used at the Jenkins and Taylor Placer, near French Gulch, Shasta County, is described by Logan [1] as follows:



Pierce gold washer and amalgamator operating at Randsburg, Kern County. Photo by courtesy of Kern County Chamber of Commerce, Bakersfield, California.



P. & H. gasoline steam shovel and Pierce gravel gold washing machine on Jenkins and Taylor placer, near French Gulch. Photo by courtesy of Clifford Taylor.

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[1] Logan, C. A., State Mineralogist's Report XXII, Chapter 2, Mining in California, April, 1926.

> "For washing gravel they have installed a Pierce Gold Machine, which is a small dry-land outfit patterned after one used in the placers near La Panza (San Luis Obispo County), where water is scarce. It carries a trommel about 4 feet by 16 feet with ¾-inch screen, through which fine gravel discharges on each side into four apron sluices 2½ feet by 4 feet, thence to 30 feet of sluice 2½ feet wide with Hungarian riffles. Coarse cobbles pass through the lower end of trommel to a bucket elevator with buckets 2 feet wide which is capable of stacking rocks 20 feet high or more. In operation this machine is dragged around on skids by the gasoline shovel which feeds gravel into the hopper. Power for the Pierce Machine is furnished by a second-hand automobile engine working through chain and gear drives. A 6-inch centrifugal pump supplies water for washing."

A Pierce Gold Dredge Machine was installed on a property near Randsburg, Kern County. This machine weighs 12 tons and digs to a maximum depth of about 25 feet. It has a capacity of 300 to 400 yards daily and requires 2 men to operate. The cost of operation is said to be about 15 cents a yard exclusive of cost of water.

Placer Gold Mining Machine Equipment. This company's equipment apparently is that covered by the Thomas Dugan patents. It appears that it can be operated either as a dry washer or combined dry and wet washer. Claim III of the patent reads as follows:

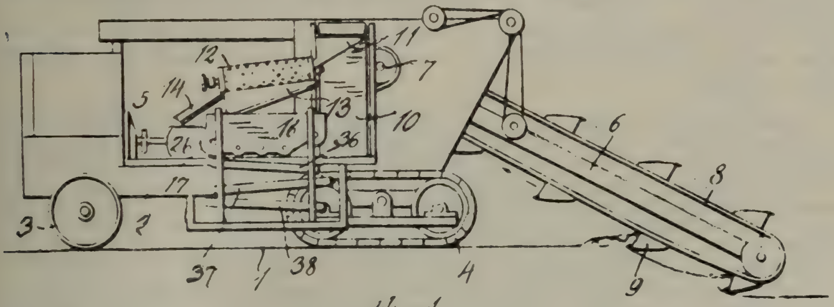

Fig. 1.

Sketch showing general arrangement.

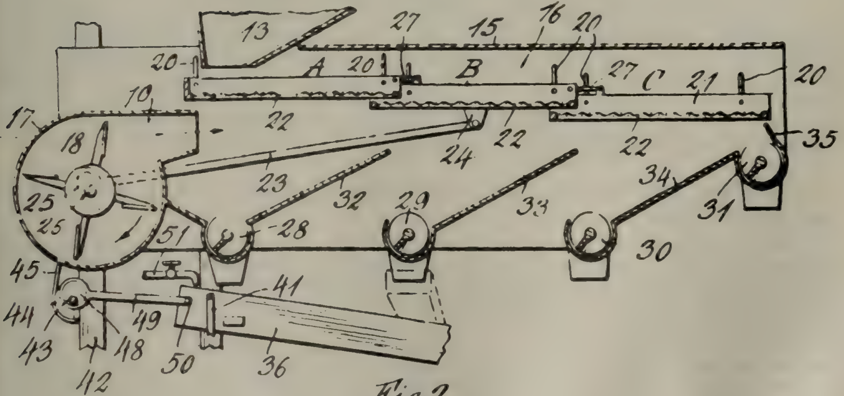

Fig. 2.

Construction detail.

> "In a Placer Mining Machine, in combination, a truck, means carried by the front end of the truck for digging and elevating materials, a screen carried by the truck means for transferring the material from the delivery end of the digger to the receiving end of the screen, a hopper located beneath the screen and adapted

to receive the screenings, a separator located beneath the hopper, the separator comprising a sectional screen, means comprising links for suspending the screen, means for reciprocating the screen, means for directing an air current along the bottom of the screen whereby any material passing through the screen will be separated in accordance with its weight, a plurality of transversely extending conveyors located underneath the screen, inclined bottoms for directing materials to the conveyors, a sluice box located underneath the transverse conveyors, and means for reciprocating the sluice boxes and for imparting to them a transverse movement."

This apparatus is not for sale but owners wish to negotiate for suitable placer ground on which to operate.

'Placer Miner' Machine. Manufactured in Los Angeles, California. No description of this apparatus is at hand.

Premier Gold Separator. This machine will handle 75 yards per day. Operated by $1\frac{1}{2}$-h.p. gas engine. A small 1-man model is also made.

Proctor-Linville Placer Machine. The Proctor-Linville Placer Machine is unique among gold-saving devices in that the material treated is caused to travel upgrade by what the inventors term a 'patent arc-flip throw.' Agitation of the gravel with resultant classification, permits the heavier particles, consisting of gold, black sands, etc., to settle and accumulate back of a set of riffles over which the lighter matter climbs.

"The machine consists of a revolving drum, a removable riffle box, and a small gasoline engine. The drum revolves on a spindle, and is chain driven. Teeth projecting toward the center of the drum, serve to break up lumps of clay or cemented gravel.

"The riffle box is supported by four inclined cantilever springs fixed at the bottom of the frame and held under tension. A rod attached to the under side of the box is connected with an eccentric which draws the riffle box downward and backward, following the arc described by the ends of the springs. Reversal of the eccentric permits the springs to draw the box upward and forward. In operation the eccentric revolves at the rate of 300 r.p.m.

"The material in the riffle box is thrown upward and forward, the lighter particles gradually working out of the box, while the water and heavy particles are retained at the lower end. The machine may be used either with or without water. When run dry it is essential that the gravel be thoroughly dried since any moisture present will hinder the separation of the gold. Ordinarily, water is fed into the drum along with the gravel. The feed to the riffle box consists of the overflow from the revolving drum. Some of the gold and the larger stones remain in the drum and are removed by the operator from time to time.

"Water requirements are low as there is practically no flow of water from the machine, the loss consisting only in that due to evaporation and absorption by the discharged gravel. On ordinary material it is estimated that 11 to 13 barrels per day are ample. The capacity of the machine is rated at 40 cubic yards per day of average "bank-run" gravel. The makers claim a gold recovery of 95% on either coarse or flour gold.

"The entire machine weighs approximately 500 pounds, but the engine and drum may be easily dismounted, the remaining part weighing less than 200 pounds. It is 7 feet long, 3 feet wide, and 5 feet high."

Quenner Disintegrator (for cemented gravels). This machine is described as follows:[1]

"The disintegrator consists of a trommel screen and a number of hammers mounted on a shaft independent of the trommel. A large size machine capable of handling from 250 to 300 cubic yards per day is made up of a trommel 6 feet long, 3 feet in diameter, with 2-inch diameter holes. The trommel is mounted horizontally on flanged wheels, and is revolved by chain and sprocket drive at about 25 revolutions per minute. A steel shaft 3 7/10 inches in diameter passes through the trommel and turns on its own journals. This shaft is belt driven. Attached to the shaft by bolts and clamps are 12 chains, on the ends of which are fastened manganese steel hammers weighing 16 pounds each. The shaft turns counter to the trommel at a speed of about 50 revolutions per minute. The revolving hammers and trommel disintegrate the gravel and carry it through the machine rapidly. Although the centrifugal force holds the chains to a rigid position when running, they do not break when a boulder too hard to shatter is encountered as would be the case with rigid rods."

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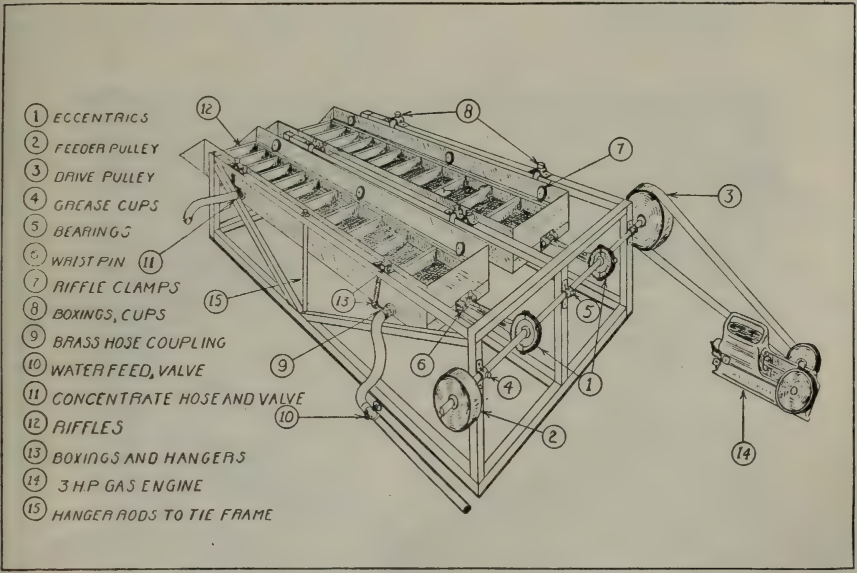
[1] Smith, Alfred M., and Vanderburg, Wm. O., Placer Mining in Nevada, Univ. of Nevada, Bulletin, Vol. XXVI, No. 8, Reno, Nevada. December 15, 1932.

The trommel undersize is diverted to the sluice box or other equipment for washing, while the oversize is discharged to waste.

Quick Kleenup Gold Sluice. A small portable rocking sluice with diagonal riffles. Can be operated by hand or power. Made in Oakland, California.

Ratcliffe Concentrator and Amalgamator. This machine is designed to handle both placer material and crushed ores and is said to have been successfully used on gold, silver, platinum, tin, chrome, manganese and tungsten since 1922. It uses only a small amount of water which may be pumped back and reused and requires only 3 horsepower to operate. The concentrator and amalgamator weighs 300 pounds. An engine will bring the total weight to about 800 pounds or a Ford car can be jacked up and the engine used to run the machine. The operation is described in a circular as follows:

"In gold we use silvered copper plates, also a quicksilver trap. The machine is simple and easily operated, automatically fed, one ore feeder will take care of two machines. The machine will put through about two tons per hour of gravel or crushed are—do not classify the product. The construction as follows: the riffle box is made of heavy sheet iron welded together, so there are no rivets to come loose. The box is six feet long, eighteen inches wide and one foot high. Riffles are four and one-half inches high, spaced wide at the feed end and narrow at the discharge end of the riffle box. Under the riffles we have a wooden riffle board in which holes are bored to let the water feed upward and under the riffles. The water comes up under each riffle forced by a gentle and steady flow from a gravity tank above the machine. On top of the riffle board we have a steel screen the holes of which are so fine as to let only the light or small particles of gold or concentrate through. At the bottom we have a chamber about three inches under the riffle board, we also have a silvered copper plate on the bottom covered with quicksilver to amalgamate the gold the same as in any gold mill.



Ratcliffe Concentrator and Amalgamator

"There is a quicksilver trap to catch any amalgam that might slip off the plate—thus we save all the gold. The inlet for the water is at the front or feed end of the riffle box with a discharge at the lower end where the light concentrates run into a sump. And the slimes that may get down under the riffles will flow over the top of the sump and the heavy concentrates will sink to the bottom of the sump.

"We catch most of the heavy concentrates and gold nuggets between the riffles lodging on top of the metal screen; this is cleaned out from between the riffles two or three times a shift, but we do not have to clean the bottom of the machine only about twice a week, according to the richness of the dirt you run."

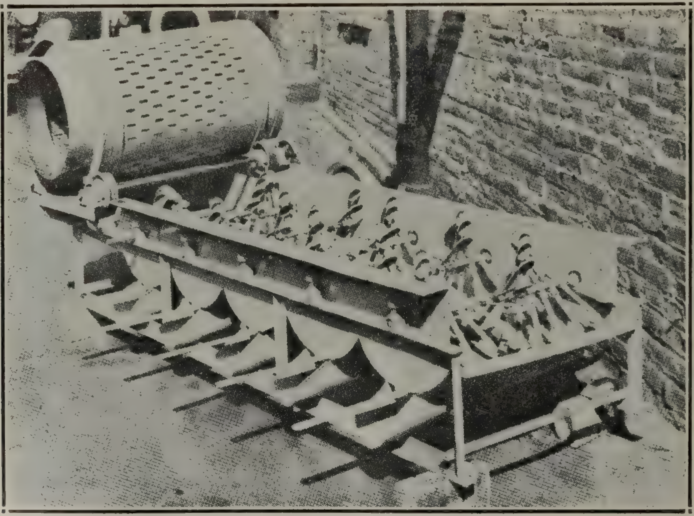
The mechanical construction of the latest model has been improved and it differs considerably in appearance from the model shown, although embodying the same principles.

Reagan Machine. Mr. J. B. Reagan writes from Kansas that he has a placer mining machine with which he expects to move Wall Street out west. No description of it is at hand.

Reagan Process. C. E. Reagan has advised the writer that he and associates successfully worked a beach placer near Crescent City in 1931, in the following manner.

The deposit is on what is known as the Bowers place, and the sand averaged 25 cents per yard for a depth of 12 feet. They used a 4-inch suction pump to pump the sand over two 3-ft. by 24-ft. sluice boxes lined with burlap and metal lath. Another water pump was used, pumping through a nozzle which agitated the sand and fed the suction pump. They were handling 200 yards in 8 hours. The boxes were cleaned once each day and the concentrates re-run through a small sluice box once a week.

Reeder Fine Gold Saver is a small compact inexpensive machine designed to separate the very fine as well as the coarse gold from gravel.



Reeder Fine Gold Saver.

"The machine is adaptable for remote sections where only a very small amount of water is available, as only a minimum amount is needed. The water can even be pumped back from a small reservoir or tank and used over and over.

"This machine appeals to the small mine operator as well as the companies operating on a large scale, owing to the low purchase price, the low power cost and the fact that it can be made small enough to be taken anywhere on an auto trailer.

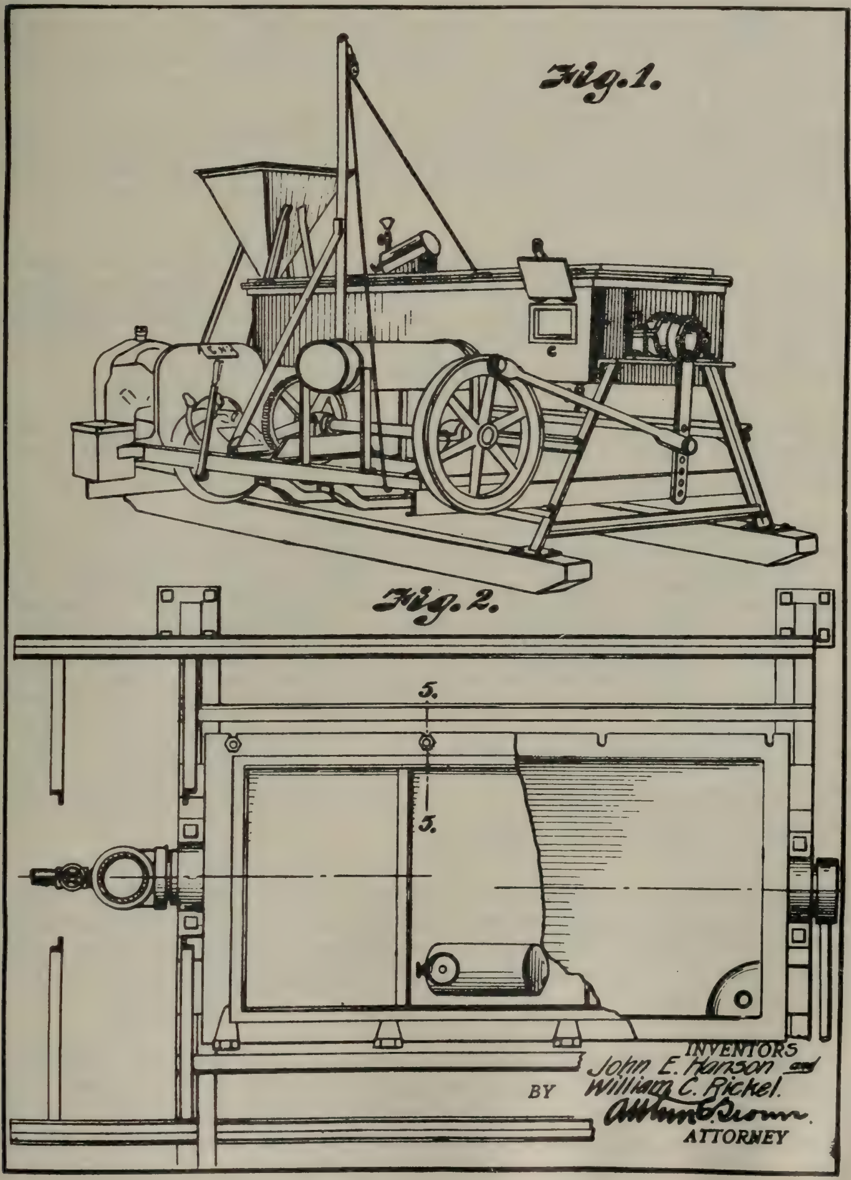
"Operating on the American River near Michigan Bluff in the sand and gravel of the river bars, the recovery of fine flake and flour gold is amazing. The Reeder Fine Gold Saver has overcome the bugbear of gravel miners from ages back by its remarkable ability to recover value from tailings dumps, gravel and sand deposits, hydraulic pits and from river and creek beds where the fine gold is continually moving.

"Hydraulic mine owners will find this machine the answer to a long felt want, since hydraulic mining is no longer practical in many sections as at a minimum cost of operation, the fine as well as the coarse gold is saved.

"The machine comes equipped with a gasoline engine which will operate at a cost from 25 to 40¢ a day. The machines at the present time are built in different models to handle from 25 to 100 yards of gravel a day. Any other size built to suit your needs or convenience. For larger operations, several units may be placed together.

"The price of the model handling from 25 to 40 yds. is $500 net f.o.b. Sacramento. Other sizes in proportion."

Rickel and Hanson Gold Reclaimer. Mr. Rickel describes this concentrator and amalgamator as follows:



Rickel and Hanson Gold Reclaimer.

"A box, made of steel boiler plate, approximately 8′ long, 2½′ wide and 18″ deep, with a lid, also made of boiler plate, the box being supported by a pivot at each end, and into one end is a feed from a hopper. At the sides, about 6″

from the bottom and close to the rear end, are openings for the discharge of waste material. The box has three distinct motions—one a jerking motion, another a rocking backward and forward motion, and an elongated motion; I mean by this that the hopper is higher than the other end, which causes the ore to travel downward. This elevation of the box can be adjusted to suit the occasion. The box is lined with copper. Riding on the lid of the box is a device that contains quicksilver, and in this device the quicksilver is gassified, and at intervals we shoot gassifying quicksilver into the box when it is in motion, while the doors are closed, thus making it water-tight. The gassified quicksilver, as soon as it enters the box, condenses and comes in contact with all gold and silver, and either takes it to the bottom and amalgamates it on the copper lining there, or amalgamates it at the top, sides or ends of the box. In the event the gold and silver are not too fine, we can eliminate the gassifier, concentrate the gold and silver at the bottom of the box, and throw the refuse off."

"This machine can easily be transported over mountains, and to other places difficult of accessibility; can be run very economically, and will handle fifty tons of ore per day; or more, according to size. The cost of the machine also will be small, compared with other layout for handling gold and silver. The machine will concentrate as many tons as desired, into one ton, thus saving the cost of transportation and smelting charges."

The accompanying cuts indicate its application to various placer operations. This equipment is manufactured by a Kansas City company with San Francisco agency. In October, 1930, a demonstration run was made on tailings at the Annie Laurie Mine, Placer County. (See *Colfax Record,* Colfax, California, Oct. 4, 1930.)

River Bar Placer Machine. A combination of rocker, long tom, dip box, and sluice. Constructed entirely of sheet-iron—rigid, secure, leak-proof and warp-proof.

"Can be operated as a stationary unit or oscillated by hand or a small engine—a variation of movements or none, just as the operator desires.

"Water can be admitted by gravity, hand dipping or by pump and the grade of the boxes adjusted according to the water supply. If water supply is low, the width of the boxes can be narrowed by reversing the side cleats. In dry diggings, where water is scarce, three barrels of water in a closed circuit with this machine will be sufficient for a day's run.

"Grade of both boxes and separator can be adjusted to meet any conditions.

"Gravel need not be screened before shoveling into box. Oversize gravel is automatically dumped to the rear of box and the water and tailings are dumped from the front end.

"Screening action can be varied by using all of the screens or none of them—just as the gravel condition may demand.

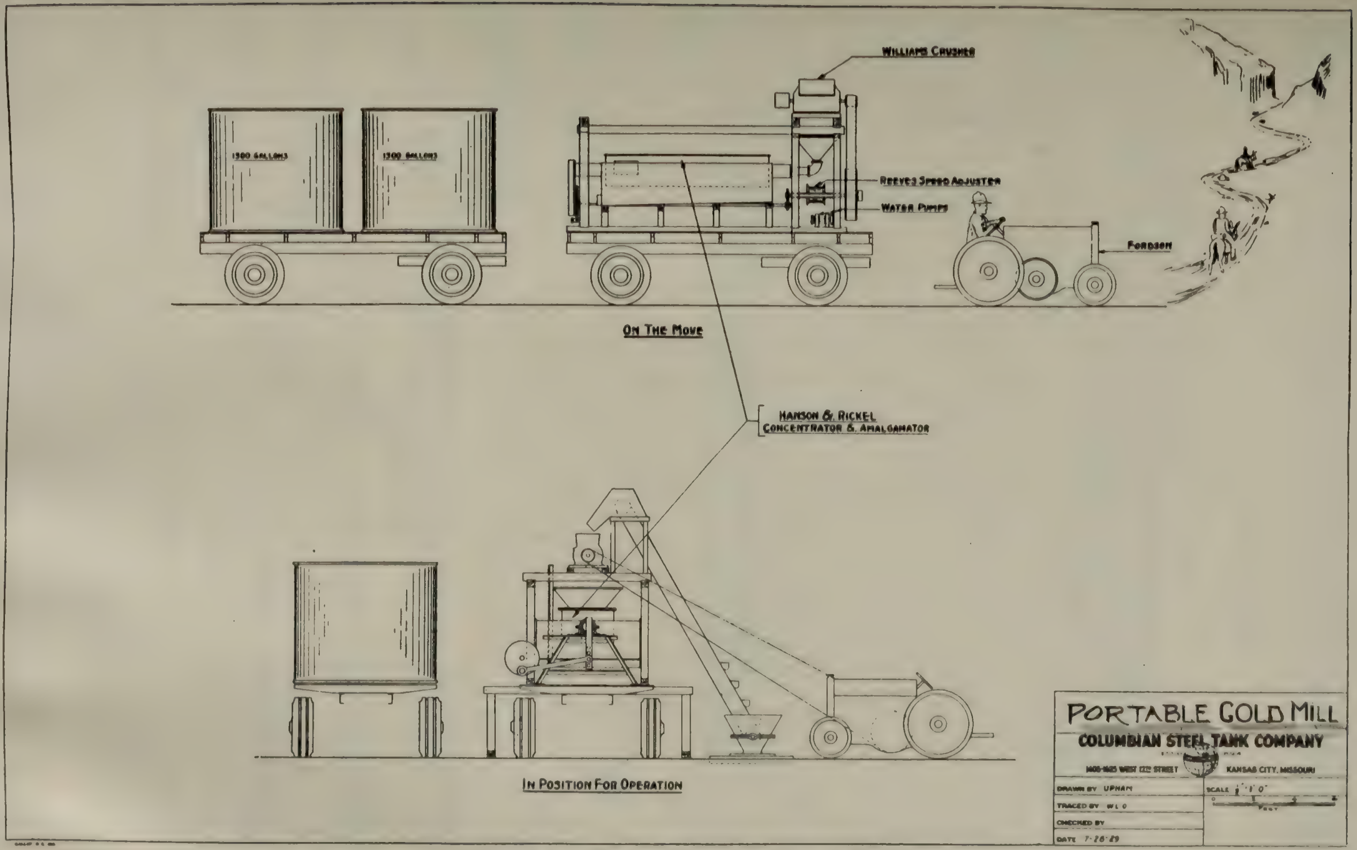
"Top box swings on a pivot, giving the miner a large shoveling space without moving the box.

"This machine is efficient, effective, positive in its action and fool proof. Has been used by the builder since 1900.

"Priced to meet present conditions."

River Mining Caisson. It is proposed to mine the bottom of rivers through a hollow metal caisson approximately 5 feet in diameter mounted on a barge, anchored in the stream. A small model has been constructed for demonstration purposes but the scheme is still in the development stage.

Root's Apparatus for Amalgamating. U. S. Patent No. 1529038. This invention relates to placer mining and has to do with apparatus for amalgamating gold and other precious metals in passing over a sluice box. The following notes are excerpts fom the patent specifications.


WILLIAMS CRUSHER
1500 GALLONS
1500 GALLONS
REEVES SPEED ADJUSTER
WATER PUMPS
FORDSON
ON THE MOVE
HANSON & RICKEL
CONCENTRATOR & AMALGAMATOR
IN POSITION FOR OPERATION
PORTABLE GOLD MILL
COLUMBIAN STEEL TANK COMPANY
1400-1425 WEST 12TH STREET
KANSAS CITY, MISSOURI
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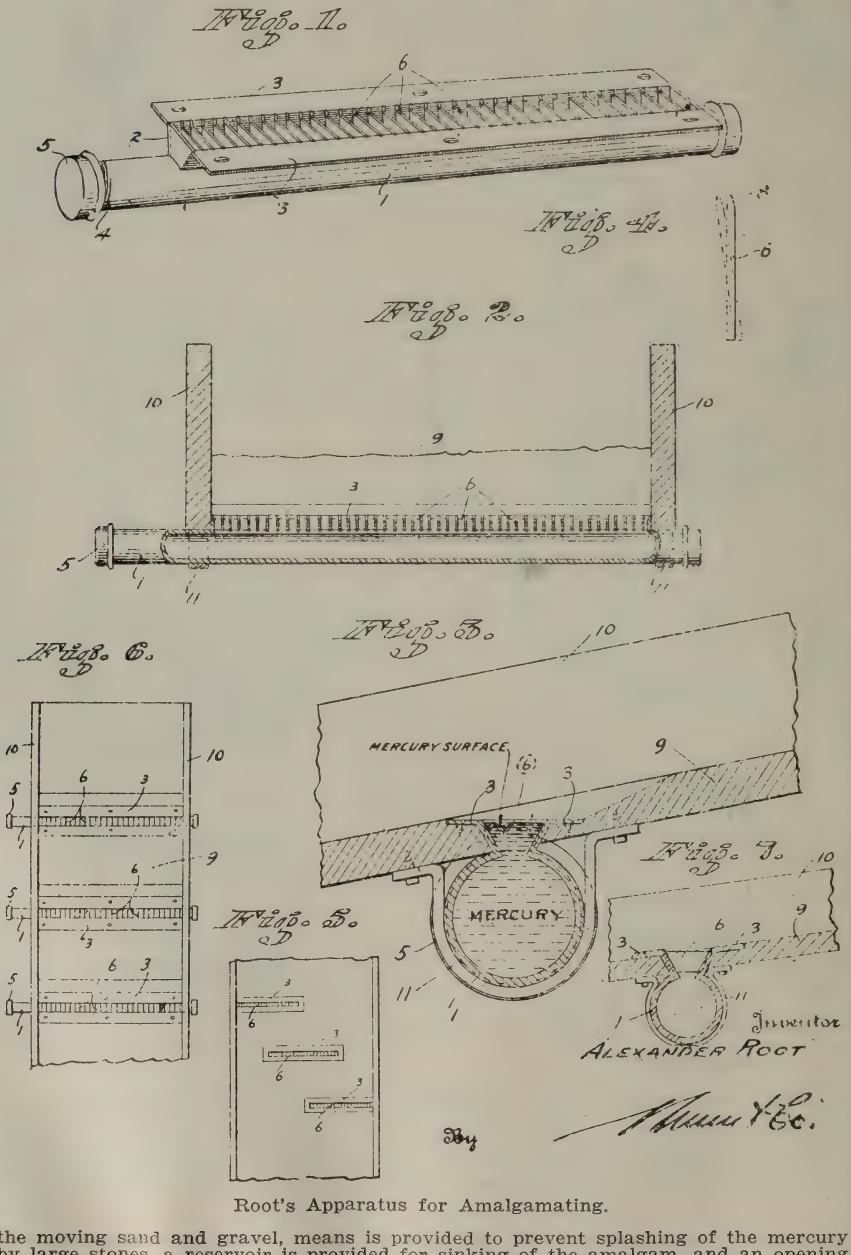
Rickel and Hanson Portable Gold Mill.

"Briefly described, the method of amalgamation consists in passing the placer sand and gravel together with water over a still body of liquid mercury whereby the values are extracted by the mercury as the material is floated over the liquid surface, and the apparatus for use therewith consists in certain receptacles for the liquid mercury adapted to be placed in the bottoms of sluice boxes, mill tables, etc., whereby the pool of liquid mercury is presented with a proper working surface to the moving sand and gravel, means is provided to prevent splashing of the mercury by large stones, a reservoir is provided for sinking of the amalgam, and an opening is provided in the reservoir for the removal of the amalgam without disturbing the setting of the apparatus in the sluice box; also other features are incorporated such as means for forming a tight connection between the receptacle and the bottom of the sluice box, easy renewal of the anti-splash features to provide for wear, etc.



Root's Apparatus for Amalgamating.

"In its preferred form this receptacle consists of a section of pipe of about two inches in diameter and having an opening or slot formed in one side with an upstanding wall of metal welded to the pipe all around the opening and flanged on both long edges. The pipe is closed or capped at both ends and at one end extends a short distance beyond the wall, so that the cap will be accessible for unscrewing and so that a wrench may also be applied to the pipe to steady it if desired.

"The walls are preferably at a slight angle and form a sort of chute about 2 inches wide on top, leading to the interior of the pipe and transversely arranged. In this chute is a number of spaced plates or grate bars to form a screen over the chute opening.

"Any form of grate or screen may be used over the opening but plates are preferred as they are easily inserted in grooves formed in the long walls or in a separate piece attached thereto.

"The bars are bent or twisted a trifle as denoted by the dotted lines in Fig. 4, or else the opposite grooves are not quite parallel, so that the plates will fit tightly into the grooves and will not float out when the receptacle is filled with mercury.

"The bars or plates are of iron or steel about one-sixteenth of an inch in thickness and preferably brought to a narrower edge on top and when all are in place they are about a half-inch apart and present a grate bar or screen about three-eighths of an inch below the upper edge of the chute. The receptacle is set in the bottom of the sluice box, the flanges being unequally set in the wood on account of the pitch of the box, so as to present a level surface to the upper edges of the chute, and the flanges are cemented and screwed or bolted to the bottom of the box to make a tight joint, while the ends are similarly cemented and form a tight joint with the sides of the box, and it is also desirable that the receptacle be additionally supported by straps passing around the pipe and bolted or lagged to the sides of the box.

"In operation the receptacles are filled with mercury to within about one-sixteenth of an inch of the upper edge, and the sand, gravel and water is run over the sluice in the usual way and when the material strikes the clear pool of mercury above the grate bars it is simply floated across by the rushing water and discharged over the far edge of the chute, thus applying a bath of liquid mercury to the moving material for amalgamation of its precious metal content.

"The grate bars provide a support for the larger stones, thus preventing splashing of the mercury, though in case of treating reduced material or pulp the grate could be dispensed with. The upper edges of the bars are as thin as practicable to reduce the surface to which any amalgam can adhere or pile up on to be carried out of the chute by the moving gravel, and being vertically arranged, permit sinking of the amalgam to the lower part of the receptacle, thus always presenting a clean surface of mercury for the treating of the oncoming material. By thus treating the moving material on a pool of still mercury flouring and loss of mercury is entirely avoided and the grate bars prevent physical loss through splashing from large stones, also prevent large stones from engaging the leaving edge of the receptacle thus insuring their constant downward travel.

"To remove the amalgam it is merely necessary to remove the cap from the pipe and take it from the open end of the pipe, and if very thick a few of the bars may be removed and the amalgam pushed out from above. In this connection it is evident that the grate bars may be all secured together like any grate, but if separate as shown it provides for removal or changing around of those most worn.

"Where a series of receptacles is used any one at a time may be emptied without stopping the flow of material by simply sliding an iron cover on top of the open chute and allowing the material to pass over it until the receptacle has been emptied and refilled with mercury. Any sand or gravel getting into the receptacle will of course float out again when the receptacle is filled with mercury."

Rose Gold Placer Machine is referred to by the manufacturers as "the invention of the age." It is briefly advertised in a circular in part as follows:

"Now comes a concentrator which revolutionizes the mining of precious metals. It is patented, owned and controlled by the Rose Gold Concentrator, Inc., and briefly it is described as follows:

"It is constructed of iron and steel, and can be made in various sizes to suit the condition of operation.

"Mining men from all sections are amazed by its wonderful, almost unbelievable work. This machine is 25 feet in length, 4 feet wide and 4 feet high. The tank of the machine holding the earth is watertight, set on a pitch of 5 per cent. The bottom of the tank is made of V-shaped troughs, and on the ridges of these troughs are compressed air pipes.

"The tank rests upon rollers, which, when in operation, gives it a forward and backward movement, together with a twisting sideways and up and down movement.

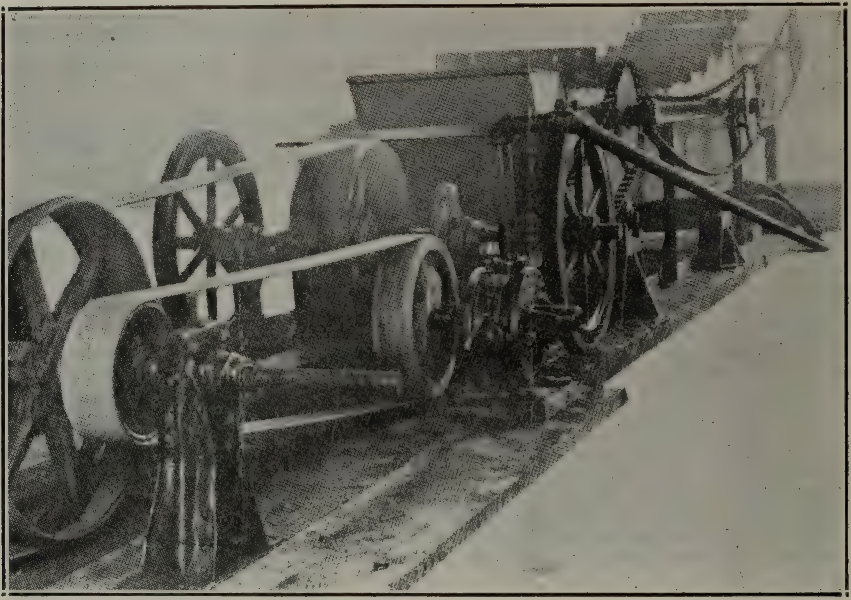
"A ten horse-power engine furnishes adequate power, which is transmitted to the machine by a pair of eccentrics. The tank of the machine is about half filled with water, together with the earth from which the metals are extracted.

"The movement described above is helped with drag chains which carry the material to the rear or lower part of the machine; with the help of the compressed air attachment, the chains keep the earth from packing.

"All metals because of their specific gravity go to the bottom and are caught in an ore pan and the waste matter is carried out of the tank by a set of drag bars, the ore being drawn off by an ore valve. Bear this fact in mind: The water in the tank remains stationary, and therefore the machine can be operated in a section where there is very little or no water, the small amount necessary being easily supplied by any conveyance.

"A careful study of the above will give you a mental picture of the machine in operation. The principle of operation is that of a miner panning, only here it is done on an enormous scale.

"Placer mining up to the present time has been conducted the same for the past twenty-five years and more. There are many methods which now all pass into the discard with the coming of this wonderful concentrator. The old methods all require much water, making mining in a dry section almost impossible, and even where water was to be had most of the values were lost. But under the old methods millions of dollars have been made, as every one knows, poor men have grown rich and rich men have become tremendously wealthy.



Rose Gold Placer Machine.

"An example of prospective earnings:

"A medium sized machine will easily handle on an average 15 tons of sand and gravel per hour. Much of the placer properties contain values running to $10 per ton, but as a conservative estimate we will take for example gravel running one dollar to the ton. The machine will in a 24-hour day handle 360 tons, or 108,000 tons per year, or bring in returns to total $108,000. That is one machine.

"For centuries the mining industry has sought to perfect a machine that would save the precious metals of the earth, and that such a machine is now a reality means the dawn of a new era in the world's mining."

Rotary Concentrator and Amalgamator.

"This process with reasonable attention, and properly adjusted, will recover 90% or better of any values contained in any concentratable ores by a gravitation and amalgamation process, recovering all free gold, such as fine floured and flaked gold that is usually a total loss by the old methods of milling treatment, and sluicing or placer mining processes.

"This machine consists of a large cylinder suspended on a stationary shaft, made from a large heavy iron pipe, from 4 inches in diameter to any desired size consistent with the size of the machine. On this shaft are fitted boxes, that support the cylinder of the machine.

"The boxes are made full roller bearing, housed in a dirtproof housing; completely antifriction bearings requiring no lubrication, of oils or greases. (There are no oils or greases to be used about the machine.)

"The cylinder to be made of wood or iron, or any other suitable material. The cylinder made in various sizes according to the capacity of the machine. The cylinder is of equal diameter at each end for some uses, but preferably is made smaller at the discharge end, for processing and concentrating of the more valuable metals.

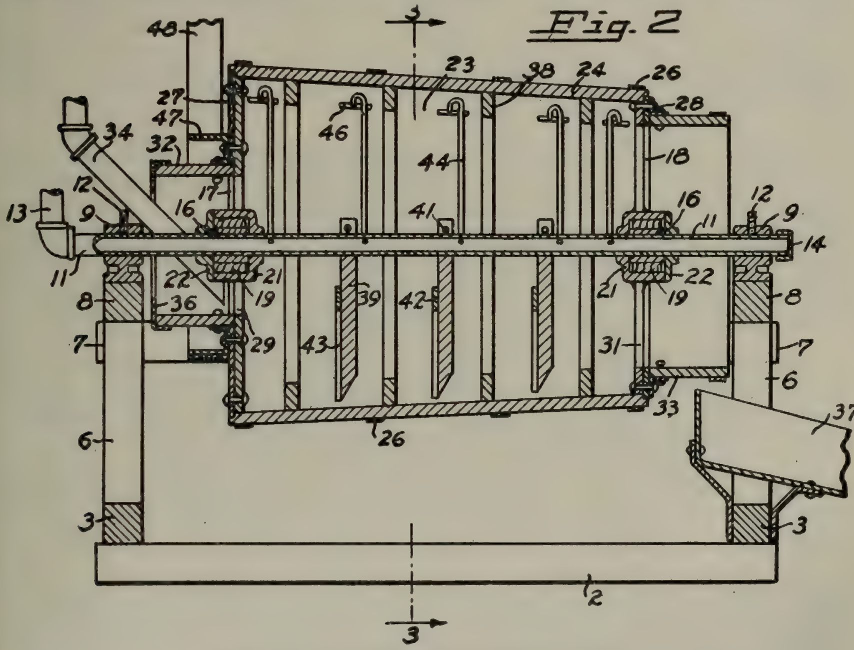
"For the processing of ores or mill tailings, where the value is recovered by amalgamation, the entire cylinder is lined with copperplate; also the intake side of the baffles are copper faced, treated and used in the same way as in the ordinary quartz mills for amalgamating of the precious metals.

"The riffles are made in two sections and can be removed at will and replaced when wanted. They are made of wood, of any desired thickness and width, in circular form to fit the rotating cylinder.

"The baffles are preferably made of wood, attached to the center shaft, and adjustable to the cylinder, to make a complete submerging of the (ores) pulps passing through the machine, under each baffle and up over each riffle. The baffles are all spaced and adjustable on the center shaft to conform to the cylinder and riffles; also the spraying pipes are properly spaced on the center of the main shaft.

"The spray pipes are spaced and taped into the pipe-carrying shaft that supports the boxes suspending the cylinder of the machine. The number and size of the spray pipes to correspond to the size of the cylinder and machine, for the supplying of sufficient water for a complete washing of the pulp from the sides of the cylinder, as the cylinder is slowing turning, also forming an adverse current to the flow of the machine; these adverse currents turning the ore, and washing out the slimes.

"These machines are built in different sizes to do the work required and wanted, either combined for amalgamation and concentration, or for concentration only, of the baser metals."



Rotary Concentrator and Amalgamator.

Rotary Dry Machine. This invention relates to a mining device having for its object to recover gold and precious metal from auriferous material and the like.

"The device consists of a mobile rolling structure adapted to operate and function by being rolled over the said auriferous material on the ground. In appearance the device resembles an ordinary lawn mower. The device or working unit comprises a hollow wheel and hub structure, mounted on an axle, the wheel being made of two discs connected in spaced relation by radial channel spokes, thus dividing the wheel into a plurality of spaces communicating convergently with the hollow hub. A hollow cone is also mounted on the axle and rigidly connected to the hollow hub by its smaller end. The combination of the wheel, hub, and cone forms a hollow unit from the wheel pickup to the tailings discharge through which the material is conveyed in the gold discovery process by the rolling action of the device.

"During the said rolling operation the cupped spoke ends in the open periphery of the wheel picks up from the ground through the screens the material to be treated, raises it up and drops it into the hollow hub from whence it is diverted by gravity and a diverting chute rigidly fixed on the axle, into the smaller end of the cone. In the revolving cone, the material goes through a tumbling, agitating, gravital, spiral action from one riffle pit down to another until discharged as dross from the large end of the cone while the values remain trapped in the large end of the cone. The device will work dry, wet or with quicksilver. The device is light and can be operated manually or mechanically, or it may be attached to an auto wheel or to a mobile vehicle in which it may form the vehicle wheels thereof in conjunction with its function as a gold saving device.

"The axle, the diverting chute and the draw tongue or shaft, form a rigid non-revoluble element, while the wheels, hub, and cone unites are revoluble on the axle. This device may be made in large units also and operated as a tractor. The device may be made to operate also in a circular path.

"Metal shot or quicksilver may be placed in the riffle pits as the settling action of same, in the agitation process, induces the gold to form a close association therewith and follow same in a strong current to the bottom of the riffles. The shot also tends to hold the fine microns from further disturbance once they are associated therewith."

Rusch Machine Separation Processes. This company is developing two distinct types of machine seperations. One is an improved *Sutton, Steele and Steele* (see, *post*) process designed to handle heavy black sand and ores broken down to the proper mesh. The other type of machine, which has been developed over a period of four years, will separate material by shape of particle and should work on light gold or flake gold. Descriptive matter will be sent to inquirers by the makers as soon as prepared and there will be a representation on this coast. Manufactured in the east.

Schaefer Apparatus. This apparatus consists of a specially prepared 8-inch or 10-inch pipe line and accessories, laid diagonally across a river bed known to carry gold. It is especially suitable below operating mines or at junctions of creeks that bring down gold during heavy rains. The inventor states that installation of this apparatus will not exceed $2,500 in fairly accessible places and that many locations can be so equipped that not one speck will escape, including 'flour' gold.

Semi-Dry Placer Concentrator. A machine manufactured in Denver said to operate on 5 to 6 gallons of water per minute and to recover 95% of coarse and fine gold with 50 tons per day capacity. Further data will have to be obtained from the manufacturer.

Sherwood Process. A chemical method of recovering platinum on a small scale from black-sand concentrate has been developed by A. H. Sherwood and used for several years. Logan[1] refers to it as follows:

"A. H. Sherwood of Oroville has for several years used a chemical method for recovering platinum on a small scale from black-sand concentrate. His process consists of two stages, (1) putting the mercury and platinum in condition to amalgamate, and amalgamating them; (2) separating the amalgamated gold and platinum. A patent has been granted him for the second stage, but not as yet for the initial process. As his rights have not been clearly defined, it is not thought advisable to fully describe the process. It is a new application of a well-known law of chemical solutions, and appears to do all that is claimed for it, giving a beautifully clean platinum and a perfect recovery which would be impossible by purely mechanical means."

The process has not been perfected to the point where it can be used on a large scale, but this is because of the lack of apparatus and not because of any defect in the method.

Smith Patented Washer, for treating sand, gravel or clay for the purpose of removing particles of precious metal therefrom. The accompanying drawing shows the main features of the washer. It is mounted on a frame provided with wheels so it may be moved from place to place. According to the patent specifications the operation of the device is as follows:

"Assuming that the parts are all arranged in operative position, dirt is placed in the hopper (47), the motor (51) started with the result that this dirt is conveyed upwardly by the conveyor (48) and dumped into the hopper (57). This dirt falls into the tank (5) and is mixed with water from the spray (62) furnished by the tank (61). The paddles (13) in revolving cause the dirt to be agitated and completely broken up so as to be mixed with the water, and as soon as the puddle thus formed reaches a level of the discharge opening (26) it will pass there through and into the funnel (27), at which point it will be mixed with more water from the spray (63), and on to the screen (28).

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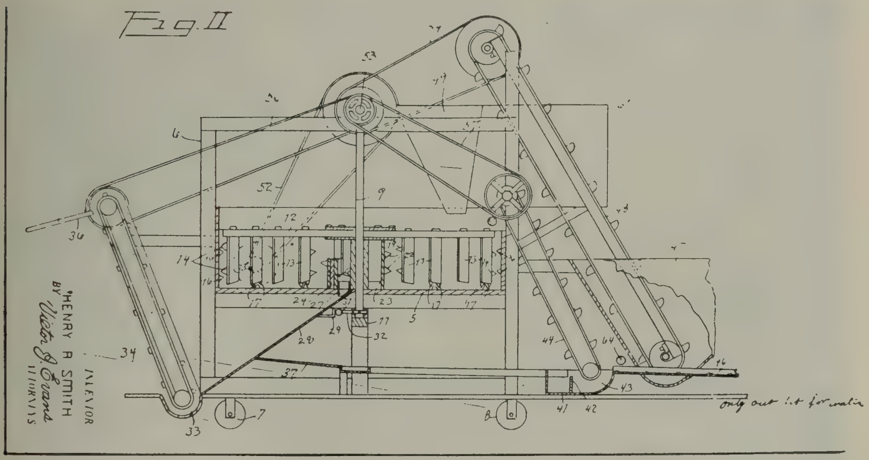
[1] Logan, C. A., Platinum and Allied Metals in California, State Mining Bureau Bulletin, No. 85, 1918, p. 98.

"As the shaft (9), which forms the striker, strikes the striker plate (29) thus vibrating the screen (28), dirt which is too large for the screen will pass downwardly and into the trough (33), from which point it will be conveyed away from the machine by the conveyor (34). The material which passes through the screen (28) will fall upon the pan (37) and will wash into the riffles (38) and (39). When this material has reached the end of the riffles the heavier gold will have been cut by the riffles and the mercury contained therein, while the sand and other foreign substances will reach the sump (41) where the settling action will take place. The sand will thus be retained at this point, while the excess water will pass over the partition (42) and into the sump (43).

"The conveyor (44) having buckets thereon will return the water from this point back into the tank. There will, of course, be some excess water which will flow over the sluice (46), but the rate of flow will be so slow, that any fine particles of gold will sink and thus be retained.



Smith Gold Washer.

"It will be also noted that a spray (64) is adapted to discharge into the sluice (46) with the result that the slight excess of water flowing thereover will be further diluted, so as to produce practically a clear water, this action resulting in the depositing of the remaining fine gold. In the treatment of black sand, the sliding gate (24) is removed and a lower gate placed therein, because in the treatment of black sand the puddle in the tank should not be over two inches deep.

"It will thus be seen that there is provided a concentrator which will handle the coarse, as well as the fine particles, and that the device might also be employed with other metals."

Special Pulp Sifting Corduroy Cloth. This corduroy cloth has been used for several years by a large number of mining companies in South Africa and during the last two years by a number of companies in Canada and the United States.

It is generally used on stationary tables set at an angle of about 30°, the tables being about 3′-6″ wide and 8′ long, similar to an undercurrent. The corduroy cloth is cut into strips to whatever width the table may be and the pieces are overlapped slightly until the total length of the table is covered. The cloth is usually held in place by flat bars about 1 inch wide and about $\frac{1}{4}$-inch thick. The slime or pulp is then passed over the tables and the gold is caught in the riffles. After 10 to 24 hours the cloths are rinsed in a vat and then replaced on the tables.

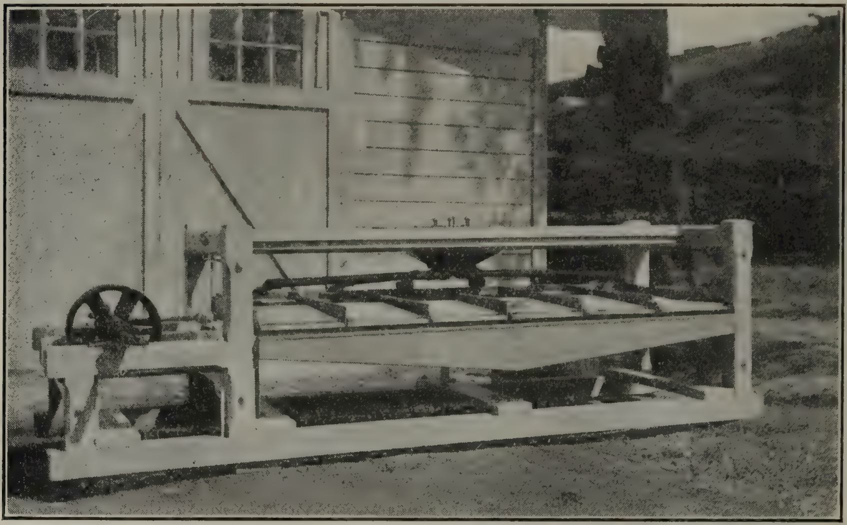
The corduroy cloth will last for a considerable time on this service, but after the pile or backing gives way, the cloths must be replaced by new ones.

The cloth is made up in widths of 28 inches and 36 inches, and in lengths of about 80 yards.

The prices of special pulp sifting corduroy cloth are: 28″ width, 90¢ per lineal yd.; 36″ width, $1.15 per lineal yd.

Straub Black Sand and Placer Machine.

"This machine consists of from one to six monel metal riffle trays mounted in a frame as shown in the photo (six tray size). These trays are adjustable for slope and are given a rapid transverse movement by an eccentric, adjustable from zero to maximum, on the drive shaft. The latter is driven at 350 r.p.m. This motion causes a boiling action in the pulp or sands between the deep riffles, so there is no packing and the fine gold can readily settle through the loose mass of black sand. Mercury may be used if desired but this is seldom necessary as a very high extraction can be obtained by the action of gravity alone.



Straub Black Sand and Placer Machine. 50-ton size.

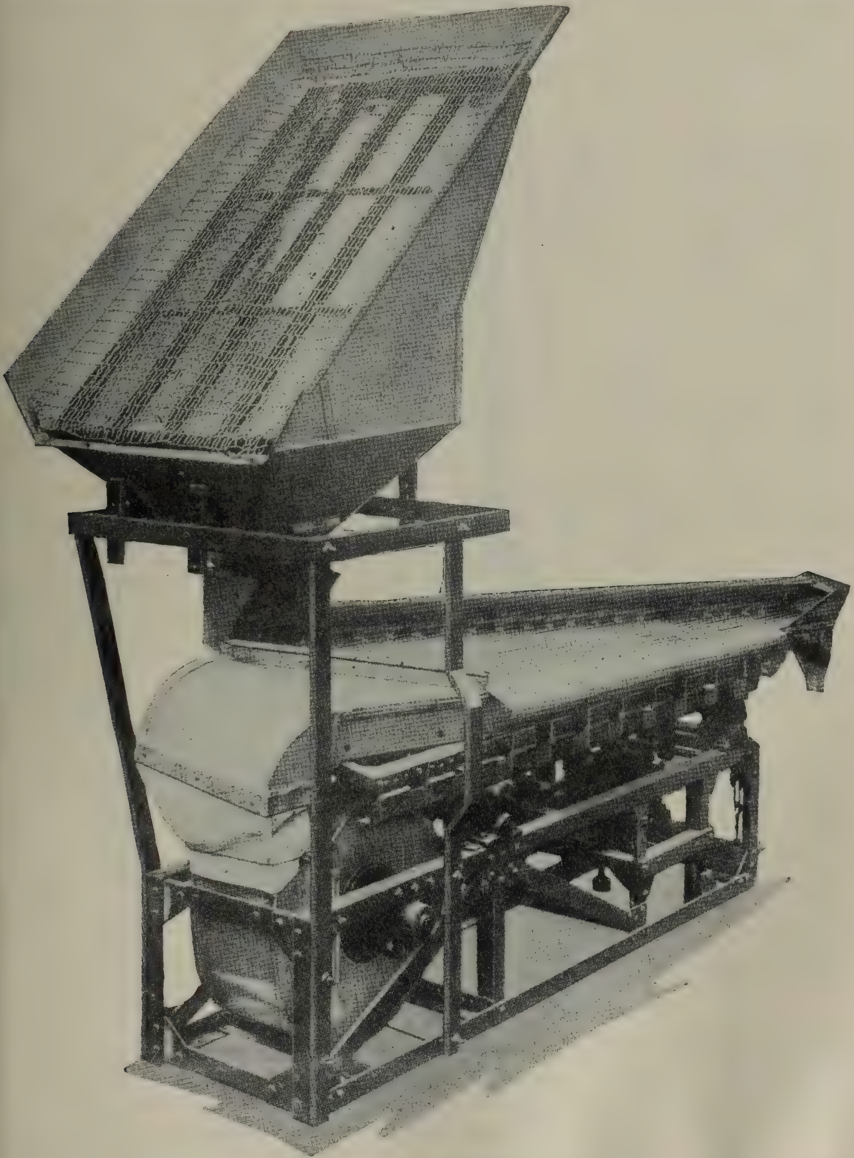
"The capacity of the machine is approximately 8 tons per 24 hours for each tray. Very little power is required, from 1/6 to 1 horsepower being ample. It works well with a small amount of water, the amount of water used within certain limits not perceptibly affecting the recovery. The machine will handle mill pulp or placer sands, the feed recommended being 8 mesh or finer. Trays are removable for cleaning up. The single tray machine weighs about 250 pounds, and the six tray size about 500 pounds making it readily portable."

The U. S. Mint uses this machine in cleaning up and concentrating floor sweepings, ashes, old crushed crucibles, etc.

The company also manufactures a general line of mining machinery.

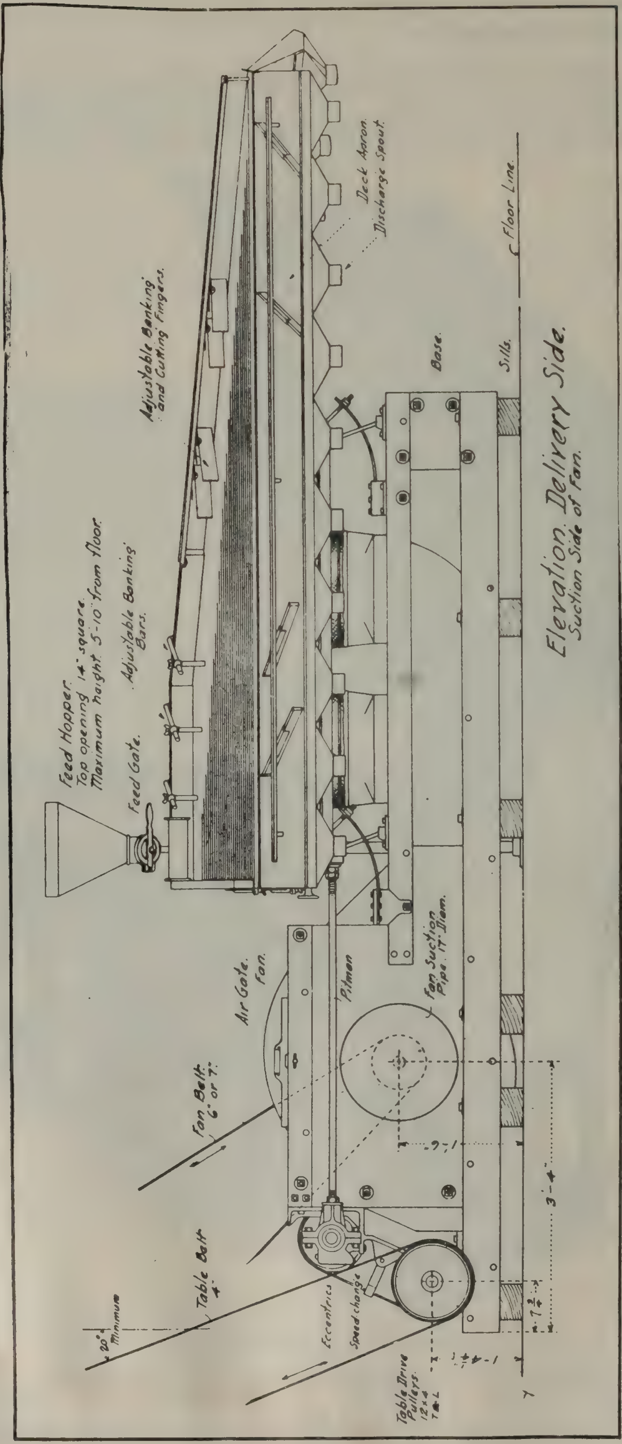
Stebbins Dry Concentrators and Separators. Several types of Stebbins dry tables have been in successful commercial use for over ten years. They are designed to treat free-milling gold ores, lead-silver sulphides and carbonates, copper, chalcopyrite, chalcocite, bornite, placer gold, platinum, tungsten, black sand, and various nonmetallic minerals and byproducts.

"The Stebbins dry placer table is used preferably on gravel which has been screened to ½-inch or finer but will handle as coarse as 1-inch if required. Black sands are said to be an aid rather than a hindrance. It is delivered as a concentrate in the ordinary course of operations and can be saved for special treatment or discarded as desired. The concentrators will handle feed containing a reasonable amount of moisture, usually any material that is dry enough to screen. In installations of any size provision is made to control the dust and if it contains values to recover them.



Stebbins Dry Concentrator No. 4.

"These dry tables have been operated in Arizona, California, Nevada and Mexico and returns from all sizes throughout are said to show a general average


Feed Hopper.
Top opening 14" square.
Maximum height 5'-10" from floor.
Feed Gate.
Adjustable Banking Bars.
Adjustable Banking and Cutting Fingers.
Deck Apron.
Discharge Spout.
Floor Line.
Base.
Sills.
Elevation. Delivery Side.
Suction Side of Fan.
Air Gate.
Fan.
Pitman.
Fan Suction Pipe. 17" Diam.
Fan Belt 6" or 7".
Table Belt 4".
20° Minimum
Eccentrics
Speed change
Table Drive Pulleys 12x4 T&L
1'-9"
3'-4"
7½"
1'-4¼"

Sutton, Steele and Steele Dry Concentrating Table.

of above 90% savings of the gold values in a free state in the gravels. The machines are built to stand up under years of service and being practically automatic in operation require little attention. They are built in a number of models and in sizes from No. 4, having a capacity of 2 tons of screened gravel per hour to No. 12 with a capacity of 25 tons. A recent development is the adoption of the Stebbins machines for the concentration of colemanite and kernite by the Pacific Coast Borax Company."

The Sutton, Steele and Steele Dry Concentrating Table. This machine was originally developed for the cleaning of seeds, but it has been adapted to the concentration of finely divided ores and minerals with considerable success. Whether it is suitable for the treatment of heavy black sands seems to be undetermined as yet but it may have possibilities.

Tests made from a total of 84 assays while a carload of concentrates was being turned out on a Sutton, Steele and Steele dry concentrator table at a mill in Utah showed an average recovery of lead contained in heads of 92.77% (galena and lead carbonate ore). Average assay of tails 0.8% lead. Concentrate produced per hour 530 lbs. (all sizes mixed). Heads treated per hour 3181 lbs. (all sizes mixed).

Taber Amalgamator is manufactured by Centripact Machinery Co. No descriptive matter concerning this device is at hand.

Thayer Electrolytic Continuous Process Gold Placer Mill. For use on placer deposits, gold dredges, recovery of values from concentrates at gold mills, etc.

"This is a mill economical to operate and extremely efficient for the recovery of finely comminuted gold (and also platinum and its allied metals, where the latter precious metals are found associated with the sands and gravel and ores) in placer deposits, black sands, concentrates at gold mills, etc.

"The mill consists of a complete operating plant, including besides the mill proper the electrolytic generator to supply the current, 4 h.p. No power is required for the operation of the mill, besides the above. The pulp mixed with water, to which is added a small amount of an acid, base or salt (to make the water an electrolyte), flows continuously through the mill, by gravity with a slight head, the barren content passing to the dump; the gold, coarse and fine, as also any gold that may be in solution in the flowing pulp stream, is instantly amalgamated with the mercury, and from time to time is recovered therefrom by retorting. Any platinum metals also that may be in the pulp stream are grabbed and held by the mercury, due to the activation of the mercury by the electric current, and are recoverable therefrom by simply washing the mercury with cold water, before retorting the mercury, for the recovery of the gold.

"The process is continuous in operation; no loss of mercury, and flouring and sickening of the mercury are entirely avoided.

"When 15% of gold is amalgamated with mercury, the mixture becomes thick; therefore the amalgamation of gold with the mercury should not exceed about 10%, otherwise it will not be possible to draw off the amalgam from the mill.

"In this mill a charge of about 7 flasks (500 pounds) of mercury is placed in the mill. When the mercury has absorbed about 10% of gold by electrolytic precipitation, the time depending upon the richness of the pulp passed through the mill, the flow is stopped, the mercury drawn off and retorted. For instance: If the ores of sands passed through the mill averaged plus or minus $2 per ton, the mill could be run continuously until about $12,500 (gold bullion) would be amalgamated with the mercury and the clean-up would be about that amount in value.

"A new charge of mercury is placed in the mill, and the operation is continued as before while the other charge of mercury with its gold is being retorted. Thus making the process practically continuous.

"It is impossible for gold amalgam to be stolen from this mill."

Thayer Process. This process besides recovering the larger particles of gold, in addition thereto recovers the fine, free float gold, also rusty and greasy gold that is now lost on plates and other mechanical means of recovery. It also recovers gold, from its solutions in cyanide, etc.

"Two powerful natural forces with pressure, are developed and utilized in the operation of the machine, namely; electrolytic precipitation and centrifugal force.

"The machine consists essentially of two cylinders, one within the other, the inside cylinder electrically insulated from the outside one. The anode is the inside cylinder, the cathode the outside cylinder.

"In the No. 1 standing machine, the combined cylinders revolve at a speed of plus or minus 350 r.p.m., the space between the inner surface of the outside cylinder and the outer surface of the inside cylinder being one-half inch.

"Into the No. 1 commercial machine are poured plus or minus 15 lbs. of metallic mercury while the machine is at rest. Means are provided for passing a continuous flow of electric current of low voltage and comparatively high amperage, into and through the machine while it is operating. Current D. C. plus or minus 6 volts; plus or minus 500 amperes.

"As the machine revolves, the mercury forms a floating mercurial cathode on the interior surface of the outer cylinder.

"The floating pulp or solution is caused to pass under pressure continuously through the machine, between the anode and the mercurial cathode wall, the latter maintained in the machine by its revolution, and at the same time, the current is caused to pass through the fluid pulp or solution, from the anode to the cathode in the machine.

"By the combined and simultaneous powerful actions of electrolytic precipitation and centrifugal force, the metallic values in gold, platinum, etc., are precipitated and drawn into the mercurial cathode in the machine, and are collected and held therein, the waste material passing to the dump.

"In addition to effectively recovering gold and platinum metals from their ores and sands, the machine recovers gold from its solution in cyanide.

"The gold in solution in cyanide (the latter being a good electrolyte), by the action of electrolysis (in accordance with Faraday's laws relating to electrolysis) is plated into and absorbed by or amalgamated with the mercurial cathode in the machine, the rapidity of action accelerated by the centrifugal force.

"Metallic mercury (in its natural state) will not take platinum, iridium, etc., but when the mercury is activated by the electric current, it takes these metals and holds them. The action of the mercury amalgamating gold is also very greatly increased by the activation of the mercury by the current. The current also prevents flouring with consequent loss of mercury and keeps the mercury clean.

"From time to time, depending upon the richness of the ores or concentrates or solution, the machine is stopped for a few minutes, the mercury is withdrawn from the machine, is strained and the amalgam retorted. In the meantime another charge of mercury is placed in the machine. No mercury whatever is lost in operating or retorting, and the values in gold are taken from the retort.

"If there has been platinum in the ore or sands, it will be found entrained in the mercury, and is recovered therefrom by simply agitating the mercury with cold water, before retorting the amalgam to obtain the gold.

"Capacity—The capacity of the No. 1 machine is about 30 tons of the "magma" or solution per hour, under a head of 10 ft.—through two 2" pipes, with ore or sands, ground to 100 mesh or finer. The ton capacity of the No. 1 machine is plus or minus 1 ton of ground ore or sands per hour, in some cases the proportion of ore carried by the water may be more or less, depending upon the character of the ore.

"If the ore or sands do not contain an acid soluble base, or soluble salts, a small quantity of either of the above, must be added to the water carrying the ore, to make it an electrolyte. The "magma" must flow freely through the machine.

"The process is practically continuous. No loss of mercury. The gold and precious metals, etc., are recovered, no matter how finely comminuted. The power for running the machines and generating the current utilized may be considered in commercial operations as very reasonable.

"1. The process fits any amalgamable gold or recovery problem.

"2. The process offers higher extraction efficiency than previous processes.

"3. The process offers a definite reduction of the theft hazard, common to all gold recovery plants and systems.

"4. The compact design and construction of the machines used in the process insure important space savings and installation efficiency.

"Machines can be built to order in larger sizes and much greater capacity, if required."

Thiebault Gold Amalgamator is designed upon a new principle which brings the finest gold into positive contact with clean amalgamated surfaces, subjected to a slight pressure, and without the aid of mechanical power.

"It also retains the gold amalgam under lock and key, permits the removal of the plate when loaded with gold amalgam, and requires very little attention when in operation.

"This amalgamator is built entirely of cast iron and copper, mainly composed of only four parts; this insures strength, wearing qualities and simplicity. The new principle used brings the material treated firmly against amalgamated surfaces which are constantly cleaned by the light scouring action set up by the sands as they pass between the plate and quicksilver. It requires no mechanical power and but very little attention to keep it in operation, and the gold amalgam can be kept under lock and key.

"The spout, an iron casting with an elongated opening for the passage of gold-bearing material mixed with water, receiving at the upper or hopper-shaped end and delivering to the underside of an inverted amalgamated plate. The spout collects the stream of moving material and delivers it to the surface of a shallow pool of quicksilver until the volume within the spout reaches a height sufficient to force the quicksilver away and permit the stream to flow between the quicksilver and the amalgamated plate, then up through the tortuous passage and over the spillway.

"Descending within the spout, this volume of gold-bearing material and water expels the air which very often surrounds the fine grains of gold: this eliminates one of the detriments to amalgamation. It delivers the material subjected to a slight pressure directly against the amalgamated surfaces, thus forcing amalgamation upon the gold. A scouring action is also created by the sands being forced between the plate and the quicksilver; this has proven essential in keeping the surfaces clean and bright.

"Gold and platinum being heavier than the quicksilver, gravitate to the bottom, while the lighter materials are kept afloat of the quicksilver and washed out with the exception of the lightest gold, which has been forced into amalgamation and is firmly held onto the plate, and the fine grains of quartz which contain small specks of gold attached. This gold amalgamates with the quicksilver and this added weight retains the quartz floating upon the surface of the quicksilver, the current of the stream not being strong enough to lift it out.

"The basin, an iron casting shaped to receive the discharge end of the spout and provided with lugs and bolts to hold the spout rigid. The bottom of this basin is shaped to contain the pool of quicksilver into which the ribs of the inverted plate extend; a drainage is placed at the lowest point and means for locking the drain cock is provided. The front wall of this basin is made somewhat in the shape of the letter 'S,' partly lined with a piece of amalgamated sheet copper; this is to catch and collect all the little particles of gold or quicksilver coming in contact with it as well as to deflect the stream to aid the heavy particles to gravitate and to bring the flaky gold against these amalgamated surfaces. The partition, which is also amalgamated, is next to deflect the stream in the direction of the spillway.

"The plate is somewhat improved over the ordinary mill plate. The amalgamation takes place on its under side and in this position it is not susceptible to catching or holding any foreign matter which would be detrimental to amalgamation. At one edge the plate is pivotally connected with the lower end of the spout section, their adjoining surfaces are planed smooth and true, the other edge is free to be held either up or down.

"Ribs spaced a little over an inch apart, and parallel with the stream, extend from the under surface of this plate down into the pool of quicksilver. These ribs fulfill three functions: (1st) They increase the amalgamating area; (2) through the aid of the chemical affinity quicksilver has for itself, they draw sufficient quicksilver up to the plate to keep it 'wet' at all times regardless of the scouring action going on by the sands which pass it under pressure; (3) they prevent any diagonal currents beneath the plate.

"The partition or baffle plate is affixed to the free end of the plate to hold it down against the stream while working. It is made from sheet copper and amalgamated to catch what gold may come in contact with it. This partition prevents any great accumulation of sands on top of the plate; also serves to direct the moving stream toward the spillway.

"Lock pins one at each end of the partition pass through holes in the sides of the basin and serve to hold the plate down. They also can be used to hold the plate up to permit inspection of the underside. These pins are provided with a hole in the point for the insertion of a padlock to prevent the opening of the basin by unauthorized persons.

"The riffle, a section made of cast iron, is placed just below the spillway as a precaution against the loss of quicksilver or amalgam. Quicksilver is sometimes splashed out if the plate be suddenly dropped from the elevated position, or if an overcharge be placed in the basin and the feed opened too wide.

"To aid amalgamation in cold climates or in winter weather, the temperature of the quicksilver can be raised by applying heat to the under side of the basin.

"There is no reason why the finest and most flaky gold can not be amalgamated as readily as coarser gold if it is brought into firm contact with clean amalgamated surfaces. This amalgamator insures this contact and yet does not agitate the quicksilver, for the stream passes over its surface.

"This machine is built in two sizes and of either sheet steel or cast iron. Tests on black sand concentrates with first machine built showed a saving of 96–97%."

Mr. Thiebault states that he will work with and assist any purchasers in their mining operations. Prices f.o.b. San Francisco, from $40 up, according to size.

Thompson Ejector Nozzle and Elevator. The device is of the ejector type, built in standard pipe sizes, and operated by pressure water (steam or compressed air may be used); does not require a suction seal, consequently works efficiently above or below water.

"The nozzle consists of a male and female ring, the male ring slotted, fitting into a cast bronze chamber provided with a pressure water connection at the side. The nozzle rings are eccentric to the chamber thus equalizing water velocity to the jets of the slotted male ring. The jets disharge at a certain angle and parallel to the longitudinal axis of the pipe. Suction end and discharge pipe secured to the chamber by flanges, bolted. It is advisable to keep the suction end as short as possible, not to exceed 15 inches for a two-inch elevator, although a longer and flexible suction may be used if pressure is regulated accordingly. The discharge may be pipe, or a combination using a short pipe above the chamber to which the same size or half inch larger reinforced, smooth inside hose may be attached. This arrangement allows free movement of the suction end without changing connection at the head of sluice box or hopper. Other nozzles may be introduced into the line without disturbing the flow of materials or action of machine. By adding nozzles properly spaced the elevator may be operated in any depth of water or for any lift above water; where the lift exceeds a certain ratio of pipe size to lift, the size of pipe and nozzle is stepped up.

"The elevator is operated with water at 150 lbs. pressure, furnished by a rotary positive displacement type of pressure pump built to stand 450 lbs. pressure, furnished with the elevator. The higher pressure available insures sufficient suction end velocity under all conditions, and in 'crevicing' bedrock.

"The suction end protection against clogging, furnished with the equipment, has proven most satisfactory.

"With the boulders and oversize kept out of the way, and the fines agitated to insure rapid feeding, the machine will easily handle in excess of the rated yardage.

"Velocity of discharge is very high, requiring some protection to the sluice box head to prevent undesired agitation at that point.

"The ratio of induced water to pressure water is 2 to 1. A 2″ single nozzle, using 56 gallons per minute pressure water, will discharge into the sluice box 168 g.p.m., less solids.

Thompson Ejector Nozzle and Elevator.

"The only part of the nozzle subject to wear is the female nozzlering, of which several are furnished with each equipment. It only requires 10 to 15 minutes to make a change.

The suction end of a 2″, 3″ or 4″ elevator, with aluminum alloy chamber, is not too heavy to be manipulated by hand (angle nozzle).

"A 2″ single nozzle, elevator weights about 90 lbs.; the elevator 44 lbs., the pump 46 lbs.; is an ideal prospecting unit, and for cleaning bedrock in shallow water. A power unit delivering 15 to 18 h.p. is sufficient to operate it at high pressure."

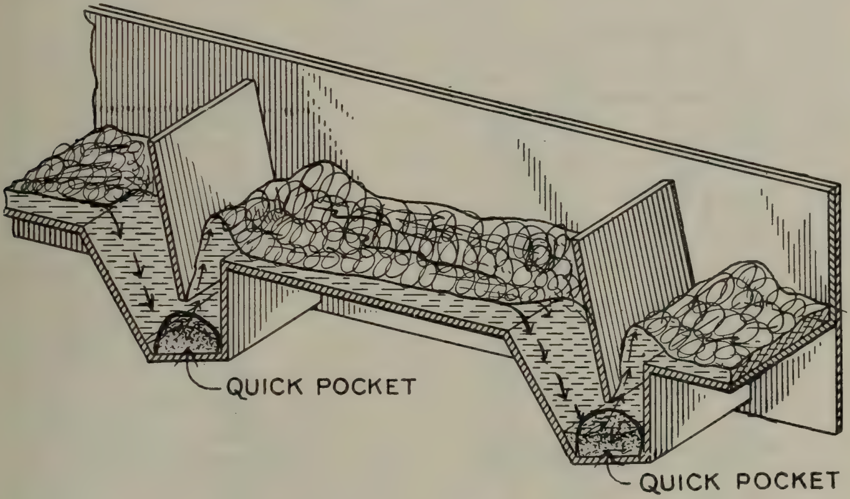
This company has also developed a flotation machine for use in conjunction with the elevator. It is stated to operate on one-third the horsepower required for 'free-air' machines and to produce better concentrates and lower tailings with a smaller amount of reagents. It can handle satisfactorily coarser material than any other machine. The actuating parts are readily accessible for examination and it is not necessary to drain the machine when shutting down or when the power goes off. Work on Pacific beach sands from Kodiak Island to Eureka, California, has shown these sands to be amenable to flotation.

Ulrich Duplex Recovery System. An elaborate system of gold washing sluices and under currents, with special rubber riffles, etc., designed to recover all the fine gold at large hydraulic operations.

Vacuum Panning Machine. This is a hand-operated continuous mechanical pan. A machine for demonstration purposes has been built, but as yet it has not been manufactured on a commercial scale.

Whitlock Gold Separator. A centrifugal bowl machine reported to make excellent recoveries.

Victory Riffle-Baffle Amalgamator is a shallow, flat-bottomed riffle box of special rust and acid proof metal 20 inches wide by 48 inches long, in the twenty-five ton size, and 28 inches wide by 68 inches long in the fifty-ton capacity amalgamator.



Cut section of Victory Amalgamator.

"Fifteen depressed quicksilver-containing troughs, or pockets, cross it transversely at regular intervals. Suspended over each trough and extending its full length is a metal baffle plate or dam whose lower edge extends down into the trough within a short space of the mercury.

"In milling practice the pulp, backed up by the first baffle plate, jets down upon the mercury below it. Passing under the baffle plate it rises in an arc and again jets down on the mercury in the second pocket. This action is repeated fifteen times in passing through the amalgamator. It is stated that heavy particles such as platinum or rusty gold that will not amalgamate, nevertheless shoot to the bottom of the quicksilver and remain. For gravel mines, dredging and all forms of placer mining the amalgamator is made in a modified form which it is claimed will save the finest float gold and yet clear itself of black sands.

W. S. C. Placer Mill. This mill was designed and built at the School of Mines and Geology, Washington State College, with the idea of producing a portable plant at a low cost that could be constructed by the placer miner. The material used was in part newly purchased but some parts were obtained second hand or from a scrap heap at no cost. The total cost of materials for this particular machine was $80.96.

The W. S. C. placer mill is described by Guy E. Ingersoll,[1] in Information Circular No. 2, a publication of the college, from which the following notes have been extracted:

"Principles Involved. The principle of the machine is simple. The feed is screened to pass fourteen mesh before it reaches the table. By so doing, only enough water need be used to carry away this fine material. The gold is caught

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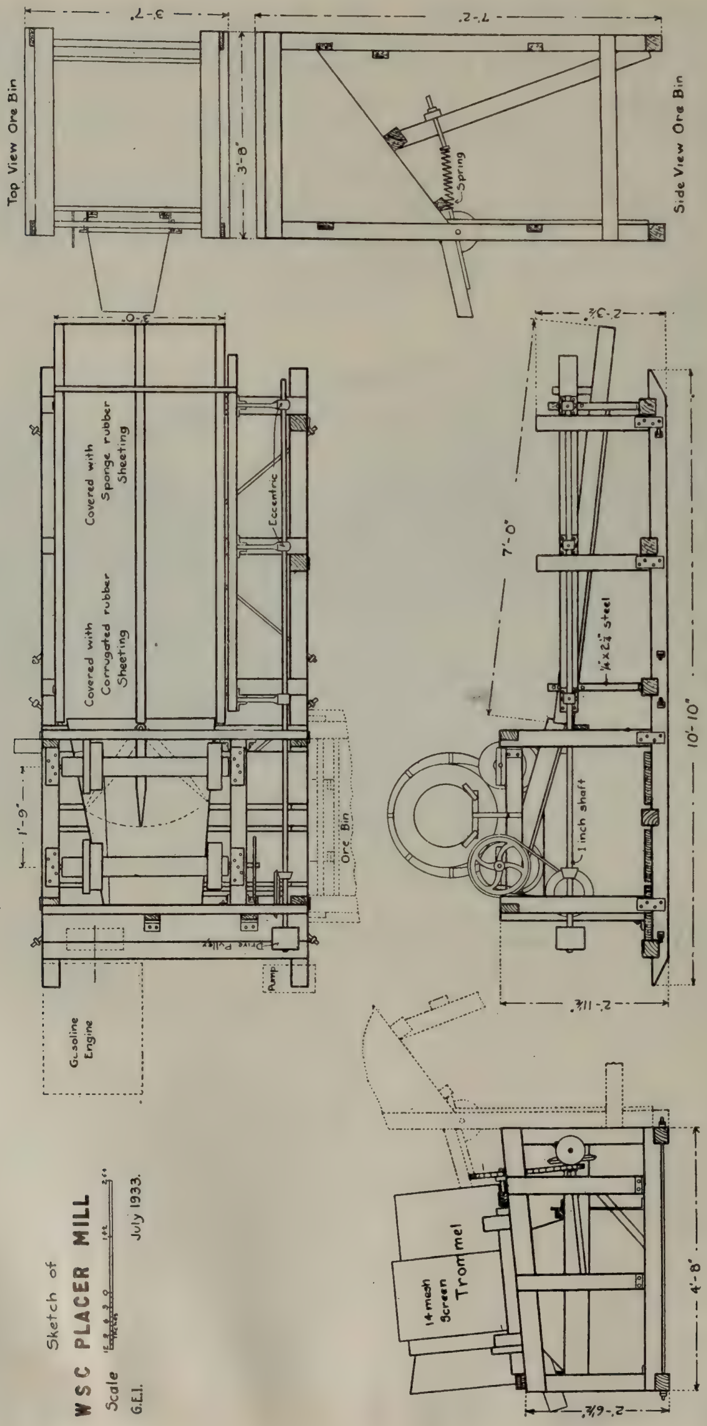
[1] Associate Professor of Mining and Metallurgy, School of Mines and Geology, State College of Washington, Pullman, Wash.


Top View Ore Bin
3'-7"
7'-2"
3'-8"
Spring
Side View Ore Bin
3'-0"
Covered with Sponge rubber Sheeting
Covered with Corrugated rubber Sheeting
Eccentric
1'-9"
Ore Bin
Drive Pulley
Pump
Gasoline Engine
7'-0"
2'-3½"
¼x2¼" steel
1 inch shaft
10'-10"
2'-11½"
14 mesh Screen
Trommel
4'-8"
2'-6½"
Sketch of
WSC PLACER MILL
Scale
G.E.I.
July 1933.

W. S. C. Placer Mill.

on corrugated rubber and sponge rubber sheets on a vibrating table. It is believed that the vibration will keep the black sand in suspension and allow the fine gold to settle out and be held by the rubber riffles. The slope of the table and the amount of water used can be varied to get the best results.

"Description of the Mill. The W. S. C. placer mill consists of an ore bin, a concentration machine with a trommel and a cleanup amalgamating barrel; a centrifugal pump and a gasoline engine. In the discussion to follow when the term "machine" is used, it refers to the concentrating machine alone.

The machine is shown in the accompanying sketch. The base is made up of two four by four-inch stringers joined by cross pieces of the same material and held together by four tie rods. Upright posts, bolted to the base, support the drive shaft and form a base for the trommel. The table is supported by four pieces of flat rolled steel of one-fourth by two and one-fourth-inch section. This allows the table to vibrate.

"The Trommel. The trommel was made of a steel oil drum and a galvanized iron wash tub. Part of the drum is punched with one-fourth-inch holes and outside of this is fourteen mesh wire screen bound onto handle-like steel fasteners which gives the wire screen two inch clearance outside of the drum. This is shown in the photographs. Small lengths of angle iron are bolted inside of the upper part of the drum to break up the gravel and disintegrate the clay. The wash tub, with the bottom cut out, is bolted onto the lower part of the drum for the discharge end of the trommel. The trommel has a slope of a little less than one inch per foot. It rests upon trunnions. These trunnions were made by rolling on and nailing belting on four-inch wooden rollers and building them up to the desired diameter. The lower trunnions are built up higher on the lower side to form a flange to prevent the trommel from sliding. Power is transmitted to the trommel by means of a chain drive to one of the rollers from a jack shaft. This jack shaft is driven from the line shaft by bevel gears.

"Cleanup Amalgamating Barrel. This is merely a 50-gallon oil drum which has been scoured out with lye to remove all traces of oil. If oil were left in the drum the mercury would not amalgamate the gold. When in use, it is placed upon the trunnions where the trommel sits. The opening in the drum is large enough to introduce the black sands and pebbles. The use of the cleanup barrel will be described under the heading 'Cleanup Operations.'

"Water. Water is brought to the machine by a one-inch centrifugal pump and carried by a pipe into the trommel, where it is perforated with small holes. Small streams of water spray the inside of the trommel, aid the screening and fall with the fine material to the sloping side or distributor head and from there on to the shaking table. Water is also delivered to the sloping slide to carry away the screen oversize. This sloping slide has an adjustable gate which is pivoted on the lower end and can be swung to either side to divert the feed to the other side or left in the center and allow the feed to go to both sides of the table. The slide is covered with galvanized iron.

"Shaking Table. The shaking table is seven feet long by three feet wide with a strip dividing it in the center so that it is really a double table. As stated above, the feed can be diverted from one side to make a cleanup or to make adjustments. The table is covered with rubber riffles. The upper parts of the table are covered with corrugated rubber sheeting of two kinds and the lower parts with sponge rubber sheeting. One kind of corrugated rubber sheeting used is similar to that used on the runningboards of automobiles. The rubber riffles extend down six feet from the top of the table and the remaining foot of the table has a strip of corrugated iron at the bottom with the corrugations parallel to the end of the table. Mercury can be placed in the corrugations to catch any gold that might get by the riffles.

"As stated above, the table is supported by four uprights of flat rolled steel of one-fourth by two and one-fourth-inch section. The slope of the table can be adjusted by means of different holes in the uprights at the lower end of the table. By this means the lower part can be lowered or raised to get the desired slope.

"The vibrating motion of the table is accomplished by means of three eccentrics on the line shaft which are one-eighth inch off center which gives one-fourth inch movement. Three connecting rods transmit this movement to a horizontal timber which in turn transmits the movement to the table. The upper part of the table is connected directly to the horizontal timber but the lower end is connected to it by a two by four which extends from the horizontal timber to the opposite side of the table.

"With the present hookup the table vibrates 400 times per minute. This vibration period can be varied by changing the size of the drive pulley on the line shaft.

"Ore Bin. It was thought advisable to use wheelbarrows to transport the gravel to the placer mill. A tugger hoist and scraper could be used if desired. An ore bin, or gravel hopper, was built to receive this material and feed it to the machine. The frame work of the ore bin was made of four by four-inch timber. It has a sloping bottom and an automatic feeding device. Under the chute lip of the bin is a feeder which extends into the trommel and is held up by a support on the machine. Under this feeder is a shaft driven by a belt from the line shaft of the machine. The feeder shaft has a cam on each side of the feeder which is in contact with steel projections on the feeder. The cams push the feeder ahead and springs pull it back. This combination shakes the feeder and causes the gravel to be fed uniformly into the trommel.

"Two large wire screens have been made which fit over the top of the bin. One of these has openings one and one-third inch square and the other has openings six-sevenths of an inch square. A wheelbarrow load can be dumped into these screens and the coarse material which will not go through them can be thrown out.

"Power. Power for the mill is furnished by a one and one-half horsepower gasoline engine. This is connected by a belt to a pulley on the line shaft of the machine. Another belt drives the centrifugal pump.

"Cleanup Operation. It is possible to clean up one half of the table while the other is in operation. To do this, the gate on the sloping side is swung to cover the side to be cleaned up. Clear water is run over the riffles while vibrating to remove the surplus material which has settled over the riffles. Some black sand will probably be found with the gold in the riffles. The rubber sheeting is then removed from the half of the table being cleaned and washed out in a tub of water. When enough of this concentrate accumulates in the tub it is put in the cleanup amalgamating barrel with some pebbles to scour off the oxide film of the rusty gold, if present. If there is any grease in the concentrate some lye should be added to cut it. Mercury is then added to the barrel and the opening is then closed tightly with the plug and the barrel is set on the trunnions in place of the trommel and the barrel revolved slowly until the gold has become amalgamated. If the barrel is made to revolve at too great a speed the mercury will be broken into very small globules or 'floured' and it will be very difficult to separate it from the black sand. The plug is then taken out and the contents dumped into a tub and the amalgam is panned out of the black sand or is run through a special amalgamating trap. The amalgam is then cleaned and retorted.

"There have been but few test runs made with the W. S. C. placer mill. Samples, which were carefully taken, were brought from points on the Columbia, Snake and Salmon rivers. The gold in these sands was fine flakes, all passing fourteen mesh. These samples were run through the mill. With these small runs no attempt was made to get a fine adjustment of the slope of the table, the speed of vibration, or the amount of water used. These tests, however, showed a recovery of slightly better than 90% of the gold. With this portable mill set up on a gravel bar with plenty of suitable material available it is expected that the gold recovery could be brought up to 95%.

"It is estimated that the capacity of this mill will vary between one and one-half and three cubic yards of placer gravel per hour, depending upon the material being handled. The size and percentage of boulders and the amount of clay and cemented material would have a decided effect upon the capacity of the mill."

Wentz Machine. This party claims to have a so-called 'dry' placer machine, which uses very little water. Its capacity is said to be 10 to 12 yards in 8 hours. Details are not available.

Wertenberger New Type Gold Saver. Details are not at hand concerning this machine. It is made in Spokane, Wash.

Wright and Mispley Gold Panning Machine. It is reported that this new type panning machine at a test made recently on a ranch four miles northeast of Lincoln on tailings and ravine gravels mined in 1850, in a four-hour run, caught gold from the size of the head of a match to half that of a pin, and also black sand of good value, which old-timers could not catch with their crude methods.

Wright and Mispley Gold Panning Machine.

The cost of operation was 11 cents for gas and oils and wear and tear on the machine. Amount handled was approximately 6000 pounds. To handle this amount by old-time methods would have taken several days.

The new machine is constructed of steel and weighs 700 pounds assembled. It takes down into four sections, the heaviest of which weighs 300 pounds. It is constructed so as to use the same water over and over, and has a conveyor to carry away screenings of no value. The machine is powered by a 4-cycle 3-horsepower Briggs-Stratton air-cooled gasoline engine.

The inventors say it is very easy to clean up values in a few minutes, due to the construction of the screening arrangement.

Other parties who have invented or built various types of placer gold recovery apparatus, about which little or nothing is known to the writer. but whose address will be supplied upon request, include:

Herbert Bostrom, Chas. E. Van Dusen, Mathew H. Mast, James R. Sweet, H. W. Merrill, C. F. Youngquist, Brown-Bevis Co., Norris & Roshong, George W. German, Davis & Davis, Wm. L. Jungbluth, J. F. McCarrville, H. D. Christensen, F. P. Godfrey, Jack Deville.

MISCELLANEOUS PLACER MINING OPERATIONS

Several placer mining operations with small dredges usually of suction pump or drag-line design at some of which a diver is employed to operate the suction nozzle have been described in the following publications: Engineering & Mining Journal, New York, April 20, 1929, pp. 628-629; September 21, 1929, p. 473; October 12, 1929, pp. 581-582; May, 1933, pp. 184-187. The Mining Journal, Phoenix, Arizona, February 28, 1933, p. 5. 'Mining in California,' July, 1927, pp. 264, 268. 'California Journal of Mines & Geology,' Jan.-April, 1933, p. 60.

Dragline and dredger owned and operated by R. E. Anderson of Marysville on Deer Creek, one mile below Nevada City near the old Champion Mine tailings. Photo by Glen de Yoe.

Steam shovel and sluices on Dry Creek, near Stanfield Hill, Yuba County.
Photo by Walter W. Bradley.

Prospecting gravel with a centrifugal pump, on Smyth Ranch, Placer County.
Photo by C. A. Logan.

DRY WASHING

In general the dry desert placers are very spotted and low grade and they have been most successfully worked by light, portable, hand-operated dry washers that can be easily moved about from gulch to gulch where the richer concentrations occur.

A number of dry washers and concentrators or air-separation machines are on the market, but most of these require power to operate and are advisable only when the deposit is of sufficient size and value or other conditions warrant installation of a more permanent type of plant.

It is essential that the material being worked be absolutely dry for satisfactory results and most failures at dry separation, where the gold is present in payable quantities, probably are due to the fact that the material when dug into to any extent becomes too damp to work by air separation.

Small hand-operated dry washers, blowers or 'jiggers' generally mounted on a wheelbarrow frame, have been used extensively in Australia. These small hand-power type of washers, though varying in details, all use the same intermittent air-pulsation principle of separation. They are built of wood, the principal parts being the frame and bellows, and above the bellows the removable riffle board. The bottom of the riffle board consists of a layer of bolting cloth held in place by a light metal screen. Cross pieces underneath support the screen and cloth and the riffles are placed over the cloth above the cross member of the frame, the whole forming the removable riffle board which is fitted tightly into the main frame above the bellows-box. Air is forced up through the porous bottom in rapid pulsations by working the bellows, and the light and worthless material is thus worked over the riffles while the gold is retained behind them. The frame holds the riffle board at an angle of approximately 30° from horizontal. Loss of fine gold may occur in a machine of this type if it is carelessly assembled; all surfaces should, therefore, be planed and tightly fitted. All coarse material is screened out of the feed before running it over the dry washer.

Drawings showing the construction of a number of different types of dry washers will be found in University of Nevada Bulletin No. 8, "Placer Mining in Nevada," published by the University of Nevada, Reno, Nevada, price 25 cents.

As a rule a dry placer deposit will have to be richer than one where water is available in order to be profitably worked. If the material to be dry washed is in ideal condition—thoroughly dry and disintegrated—and particularly if the gold is coarse, a good recovery can be made by this method. In most cases, however, the recovery will be from 10% to 15% less than wet washing would give.

BLACK SAND TREATMENT

The statement, though literally true, that ''there are millions of tons of black sand on the beaches of California containing gold, platinum and other valuable metals and minerals'' has caused much waste of energy and money in vain attempts to work them on a large scale.

Black sands have been investigated from many angles and over a long period of years: For their gold content; for their contained platinum-group metals; for the garnet, zircon, monazite, rutile, corundum, titanium and other rare minerals found in them; as an ore of iron; for the manufacturing of chrome and titanium steel and other alloys or compounds; after roasting and grinding, for use as an iron-oxide paint pigment; for making heavy concrete masses such as balance weights on bascule bridges; briquetted with some form of binder into artificial cast-iron weights, such as window weights, and for other purposes.

Typical analyses of black sand from Californian sources show an average content as follows:

Magnetite	500–1100 lbs. per ton
Chromite	10– 125 lbs. per ton
Ilmenite	200– 600 lbs. per ton
Garnet	1– 80 lbs. per ton
Quartz	200–1000 lbs. per ton
Zircon	15– 25 lbs. per ton
Unclassified	100– 200 lbs. per ton

together with variable amounts of native gold and platinum.

If each of these mineral constituents could be cleanly separated at sufficiently low cost from all others and sold independently, mining of the beach deposits might develop into a meritorious enterprise. But for all practical purposes at the present time, the value of these deposits is measured almost exclusively by their precious metal content, and this paper is concerned only with the recovery of such values.

It may be safely said that the natural concentrations of black sand in beach deposits are very low-grade—much lower grade than is usually admitted by those who would exploit them.

On the other hand black sand concentrates derived from hydraulic mining operations, dredging and other forms of placer mining by the aid of special equipment, may have a value up to several thousand dollars per ton. These two classes of material should not be confused when discussing black sand.

Very few attempts have been made to systematically prospect and sample the beach deposits, either those on the present beach or the old beach deposits now lying above and one to five miles inland from the present shore line. Such samples as have been taken by government investigators and others indicate that these deposits as a whole generally contain only a few cents per ton in gold with many samples showing no values whatever.

Experience has shown that in many cases error has been made because the gold content of a particular sample or deposit was not known. Fire assays of representative samples by competent assayers give accurate results and should be considered final in determining the gold content. The concentrating action of waves and ocean currents is erratic and the deposits vary in both extent and content within narrow limits. The maximum value that may be expected in moderate quantity will not exceed 40 to 60 cents per ton. A few individuals have been able to make a living by working exceptionally high-grade spots by hand methods and a few operators have reported success working on a somewhat larger scale, on material which ran 25 cents per yard. All attempts, however, to work these sands in California on a large scale have thus far invariably ended in failure. The impression has been given out that these failures have occurred because the gold and platinum is supposed to exist in some peculiar form and that it can not be recovered by any known means. This idea is not borne out by facts. It has been shown that the gold is entirely amenable to cyanidation and to chlorination. The flotation process has recently been applied successfully to the recovery of free gold in ores, and there does not appear to be any reason why the fine free gold in black sand can not be recovered with equal success by this process. Tests recently carried out by A. W. Fahrenwald[1] on Snake River (Idaho) sand, and black sand concentrates made by sluice box, show recoveries of 92% to 97.3%. On black sand concentrate having an assay value of 50.22 oz. per ton, the flotation concentrate contained 8620.00 oz. per ton and the tailing 1.67 oz. The smallest gold particles in this particular river sand were estimated to require 4,000,000 to equal in value one cent. A recovery comparable to that of other metallurgical processes can also be made by gravity concentration and straight amalgamation or modified forms of amalgamation and by special machines.

Mining and washing black sand on the beach at Crescent City, Del Norte County. Photo by W. C. Colley.

The gold and the platinum, when present, are usually found in very fine flakes and scales and much of the gold in the old beach deposits is

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[1] Flotation of gold from River sand and black sand. The Mining Journal, Phoenix, Arizona. April 30, 1933.

'rusty' or tarnished. This makes it somewhat difficult to save in the sluice box or to amalgamate.

To aid in the recovery of fine gold in the sluice box it is customary to line the bottom with various materials. Among those used are cocoa matting, Brussels carpet, blanket, burlap, canvas, corduroy, moss, cowhide with the hair on, sponge rubber or other similar materials. These are held down by cleats, expanded metal or wire-netting so that they can be readily removed and the gold, platinum and black sand washed out in a tub or pan for further cleaning.

Satisfactory amalgamation of the 'rusty' gold usually can be accomplished by grinding the material to scour and brighten it so it will be taken up on contact with mercury. Such gold will also readily amalgamate in the presence of a solution of cyanide. Potassium or sodium cyanide solution attacks or dissolves gold and for this reason its use must be well understood or loss may occur instead of gain. Cyanide is a deadly poison even in weak solutions and it must be handled with care by an inexperienced person or its use avoided. A copper-bottomed miner's pan is best for amalgamating. A coating of mercury can usually be worked into the bottom of such pans if they are perfectly clean. A perfect coating can be obtained also by dissolving some water-soluble mercury salt, such as mercuric chloride, in a small amount of water and pouring the solution in the pan. The mercury will then deposit on the copper. Another way is to dissolve a little quicksilver in a small amount of nitric acid. After the acid has taken up all that it will, dilute by adding considerable water (the idea being to have a very weak acid solution). Pour this in the pan and in a minute or two the copper should be coated with quicksilver. Pour off the solution. Additional quicksilver may now be added and it will take hold of the copper.

Separation of the platinum from the black sand is more readily made if the concentrate after amalgamation of the gold is screened and the different screen sizes treated as separate lots or the whole ground to a uniform size. The material should be dried and then by blowing and careful use of a magnet, a very clean platinum concentrate can be obtained. Patience and careful hand work are required.

Though perhaps too complicated for the individual, the methods described by Logan,[1] used by some of the dredging companies in cleaning up and treating their black sand concentrates, are given, as certain features may be adapted to small-scale operations.

The long tom is in universal use on dredgers to clean up. Sometimes a portion of the platinum is directly recovered in the long tom with the main part of the amalgam, but most of it is in the residual black sand concentrate, which also contains amalgam, rusty gold, scrap iron, and lead. This concentrate is run down to small volume usually in the long tom. The base metals are separated and saved. They contain some amalgamated gold which is recovered by running the metal into a bar and shipping to buyers, or sending in the accumulated base metal periodically for smelting. The platinum is recovered by panning the final long tom concentrate several times. Its separation from the small amount of gold is easy because it will not amalgamate without special treatment, but the panning is slow and must be carefully done. In many cases the black sand receives no further treatment, but is stored so that it is available for the application of any improved methods of recovering the values remaining in it. This outlines roughly the practice of many dredging companies, but each of the larger companies has its special methods for treatment of the black sand after the recovery of the main batch of hard amalgam, and these processes will be described.

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[1] Logan, C. A., Platinum and allied metals in California: Cal. State Min. Bur., Bulletin No. 85, 1918.

Methods Used in Feather River District

At Oroville, the Natomas Consolidated gold man collects the black sand concentrate and amalgam in a box on each dredger and runs it through a long tom till it is reduced to one-half a small water bucket full. The long tom used is one foot wide, twelve feet long and rests on the gold tables so that it has a grade of one inch to a foot. The upper four feet of the long tom are covered with small iron riffles in solid sections one foot long, the cross riffles being an inch apart and sloping back. Below these, the bottom of the box is lined with cocoa matting under expanded metal. From this long tom the concentrate is taken to the clean-up room. The bulk of the amalgam is separated easily and is retorted. The black sand containing platinum and a little amalgam and rusty gold is washed several times in a miniature long tom and the bulk is reduced to about one pint. This contains the gold and platinum group metals. The surplus quicksilver is drawn off, and the concentrate is subjected to a 'boiling' motion, which is imparted by pouring it back and forth between two ordinary crockery bowls. This removes nearly all the black sand. Concentrated nitric acid is applied to remove any base metal and to brighten the rusty gold so that it will amalgamate. The platinum can be finally cleaned by magnet and blower to remove the remaining black sand. All the black sand is saved for future treatment.

Some of the clean-up men at Oroville have made use of the Kellogg black-sand machine to recover the platinum from the long-tom concentrate.

Platinum in this district, as well as in the other central California dredging fields, is uniformly fine, either as flakes or grains. It is probable that the best results are not obtained in the ordinary practice where panning and the long tom are used. The pan tubs used by Oroville Dredge, Ltd., gave up after careful final cleaning 12.2% of the annual platinum yield, which had escaped during the monthly clean-ups. How much more platinum remained after this last panning is problematical. The dredging superintendents generally are satisfied with any results which approximate the usual yield of platinum. They reason that the platinum is in such small quantity at best that more careful work is not justified.

Methods Used in the Yuba River District

Yuba Consolidated Goldfields have devoted considerable attention to the treatment of the black sand concentrate obtained on their dredgers. Their investment in plant and labor for this work is justified when it is remembered that each of their large dredgers gives three tons of sand concentrate a week and a total of 60 to 70 tons of this product is treated monthly. The sand handled is the black sand from the long toms, one of which is used on each dredger to recover as much gold and platinum as can be gotten in a rich concentrate of small bulk. The handling of this residual black sand concentrate does not differ materially from the practice described elsewhere for other properties, but the work done in the sand plant is different from the methods followed elsewhere.

Thirty per cent of their gold passes the 200-mesh screen and 20% passes the 20-mesh screen. A small mill used here consists of a steel cylinder containing 150 pounds of odds and ends of iron and steel, shop waste, ends of bucket pins, and so forth. A charge of a thousand pounds of wet sand, 10 pounds of mercury and one ounce of 1% cyanide solution is put into the mill which is then run at 11 revolutions per minute using a 7½-h.p. motor, for about one hour with the mill entirely closed. The mill is then opened and the charge is emptied into a set of five sluices each 1 foot wide. There is a water valve back of each line of sluices. After dumping, the sand is run through these sluices on a grade of five-eighths inch to one foot. Sand passes first over about 50 feet of auger hole riffles which are one-half inch deep and one inch in diameter and bored straight; then over 3 feet of copper plate. At the upper end of each sluice section there is a mercury trap; there is also another mercury trap which should be mentioned at the very head of the sluices. The company claimed that they had treated several thousand tons of black sand concentrate in this way and that the tailing loss was only 50 cents per ton from sand which averaged $60 per ton in gold. This company has not used any special equipment on the boats. Each dredger has 9000 square feet of riffles including quicksilver trap riffles each holding 8 pounds of mercury. The dredge riffles are set on a grade of 1½ inches per foot and are divided into sections 1¼ feet wide. The clean-up is made once in 28 days.

The Neill jigs have been in use on some of the dredgers of the Natomas Company. Alterations were made in the jigs to fit them for this particular work. The beds were flattened and the velocity of the approach of the feed to the jigs was lessened, giving improved recovery.

Clean-ups made by the Marysville Dredging Company give much finer-sized platinum than that at Hammonton. After the recovery of the hard amalgam in the long tom on the dredger, the black sand is sacked and brought to the clean-up room. It is first run through a long tom 12 feet long which is fitted with iron riffles. Most of the amalgam is saved here. The sand is then rocked in a common rocker. It is next ground in batches of about two buckets for one-half hour in a three-foot arrastre. A little sulphuric acid is used to brighten the rusty gold, most of which is caught in the arrastre. The sand is finally washed through a Colorado amalgamator, which is said to get the remaining values. The concentrate from the long tom, rocker and arrastre is panned three times to get out the platinum.

Method Used in Natoma District

There is a high percentage of black and rusty gold here in some of the old terrace gravels remote from the present stream. The operating company states that most of the platinum saved is caught in the base trap of the long tom which is used on the dredger to recover hard amalgam and base metals. It is stated that the Neill jigs do not save any platinum, although successful in gold saving. The final recovery of platinum from the sand is largely in the Senn pan-motion batea. A small Hardinge mill is used to grind the sand. From this mill it passes onto an amalgamated plate two feet wide and ten feet long and thence to the Senn machine. This is operated at 160 r.p.m. The concentrate given is 10% to 30% black sand. The gold is practically all amalgamated on the batea and the platinum is caught in the bowl at the center. This machine was modified according to the ideas of E. E. Strouse, the company's gold man, and the bowl is larger and deeper than on the stock machine. In finally separating the platinum, the batea concentrate is screened. It is found to be much easier to get the platinum from sand of its own screen size, than from sand of all sizes. Some sand stops on a 40-mesh screen; some of the platinum and sand grains are fine enough to pass 100 mesh. The material entering the Hardinge mill carries about $75 a ton in values, and the tailing from the Senn batea is said to assay $1 gold and $1 platinum. If these figures are correct, the process saves 97% of the precious metals.

USE OF SODIUM AMALGAM

Sodium amalgam has been much touted as a 'cure-all' for the trouble encountered in amalgamating 'rusty' and tarnished gold, and more particularly for its property of amalgamating platinum. However, there are serious drawbacks to its general use.

Through the action of grease or certain oxides, sulphates, sulphides and chlorides of base metals usually found to some extent in black sand concentrates, the quicksilver used in amalgamating may become 'sickened' or 'floured.' Sodium amalgam has a powerful reducing action which will reduce the base metals from their compounds and they will then enter the quicksilver and amalgamate with it. Platinum as well as these base metals will also amalgamate with sodium amalgam. Under close technical control where the exact proportion of sodium to mercury can be controlled, it has some possible advantages in keeping the quicksilver in good condition and 'active.' In the presence of water, however, sodium hydroxide (soluble) is formed and the beneficial effects are soon destroyed. If used the resulting amalgam is base, often containing gold, platinum, iron, copper, lead and other metals. The U. S. Mint will not purchase such amalgam, so that the miner now has another refining process on his hands, that of separation of the gold from the platinum and other metals, or he must ship the amalgam to a platinum refiner. Furthermore both metallic sodium used in preparing sodium amalgam and the amalgam itself must be kept away from air, usually under naphtha or kerosene, making them troublesome to handle.

Sodium amalgam is prepared by heating mercury in a dish in the open air. Small fragments of sodium about the size of a grain of wheat are cut from a stick of sodium and dropped in the hot mercury. As each piece strikes the surface there is flame and slight explosion. This is continued until the mercury becomes pasty, or until it will just stick to a bright iron nail. The use of sodium amalgam should be avoided by anyone except a trained metallurgist, as otherwise the operation is almost certain to end in a mess.

Trouble with grease may be remedied by giving the concentrates a wash of soda (soda ash) or lye and 'floured' quicksilver can usually be made to reunite by the addition of cyanide solution or by agitating it thoroughly with very dilute nitric acid to clean it.

Sanborn [1] gives the following method for recovering gold from small amounts of concentrates:

In the final recovery of gold from a washer, sluice-box or other gold-saving device, it often is possible to reduce the bulk of concentrates to a few pounds by careful panning. A simple method of recovering the gold from such concentrates is to place it in a large bottle to be worked on the principle of a 'clean-up' barrel. To do this, place the concentrates in a bottle—not more than one-fourth full; add water until it is about one-half full, and sufficient quicksilver—at least a teaspoonful. The addition of a teaspoonful of lye for cleansing purposes is advisable. While seated, slowly tip and roll the corked bottle back and forth on your lap. After doing this for about fifteen or twenty minutes all the gold should be amalgamated. The mass is now emptied into a gold pan, more quicksilver is added and the material is panned until only a small amount of the concentrates cover the quicksilver. Hold the pan in a horizontal position and see that the mercury is in one mass. With a rather sudden tilting of the pan the gold-bearing quicksilver can be poured off; if any remains behind, add fresh quicksilver to it and repeat the pouring off process. Clean, active, quicksilver should not flour or form little globules, but should come off leaving little if any in the pan. The quicksilver is now poured into a wet chamois skin that has been laid over a cup in such a way as to form a pocket. The chamois is next twisted down onto the quicksilver—like wringing water from a wet cloth—in such a way that the quicksilver will pass through the chamois leaving hard amalgam. Some of the very fine particles of gold will also pass through the pores of the hide, but the amount will be small and this can later be saved by retorting. The hard gold amalgam can be heated gradually in the open to drive off the quicksilver, or it can be treated with hot dilute nitric acid; the acid will dissolve the quicksilver, but not the gold. Fumes of mercury if inhaled are dangerous, therefore any heating to drive it off should be done in the open.

Small balls of amalgam can be retorted by the following simple method known to many placer miners. Cut a large raw potato in half, scoop out a hole to hold the amalgam and place the latter on a shovel or iron plate using the potato as a cover. Heat over a hot fire to distill off the quicksilver. This will leave the gold sponge on the iron and part of the quicksilver can be recovered from the potato pulp by panning it. Boericke [2] gives the following method: A good sized potato is cut in half and a large enough hole scooped out to hold the amalgam. The two halves are then wired together and placed in a bed of hot coals. After the potato is baked, the gold is found in the cavity, and some of the mercury which has condensed in the pulp can be recovered. Do not try to eat the potato after using.

Occasionally gold is found, especially placer gold, that will not readily form an amalgam with quicksilver. If a small amount of lye added to the water does not sufficiently clean such gold, a little potassium cyanide will usually be effective. A piece of cyanide equivalent in size to a small marble added to half a gallon of water may be sufficient to brighten 'rusty' gold. Cyanide of potassium is a dangerous poison and is not recommended for general use for this reason.

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[1] Sanborn, Frank, Mineral Technologist, State Division of Mines.

[2] Boericke, Wm. F., Operating Small Gold Placers, John Wiley & Sons, New York.

MARKETING OF GOLD, PLATINUM, AND BLACK SAND CONCENTRATES

Gold

The domestic price of gold which had remained fixed for more than 100 years at \$20.67+ per fine ounce was advanced in August, 1933, to approximately the world open market price in London, between \$29 and \$30 an ounce. Thereafter the price was set daily by the Secretary of the Treasury, until it was finally fixed in January, 1934, at \$35 per fine ounce, the present (April 14, 1934) price paid by the U. S. mint.

The rules and regulations governing the purchase of gold by the mint were likewise changed several times and are still subject to change without notice.

The U. S. mint at present will accept not less than 2 ounces (troy) of pure gold in the form of retort sponge, lumps, nuggets, grains or dust, free from earth and stone or nearly so. As the fineness of native gold varies it may take 2½ to 3 ounces of native gold to equal 2 ounces of pure gold (1000 fine), the minimum amount acceptable. Retort sponge (gold amalgam with the quicksilver expelled) must be over 200 fine, i.e., more than one-fifth pure gold.

Actual producers shipping direct to the mint must submit Form TG-19 in duplicate, sworn to before a notary public, when deposits are more than 5 ounces gross. In cases where the shipments are less than 5 ounces the notary public acknowledgment may be omitted, but the Form TG-19 must be submitted.

Gold will be paid for by check or currency at \$35 per fine ounce (1000 fine) less ¼ of 1% handling charges and the usual mint refining charge. If the material contains silver it also will be paid for at a price closely approximating the open market price, but the mint does not pay for any platinum that may be associated with the gold. The mint buys gold and silver only; no other metals. It does not receive or assay rock, ore, black sand, concentrates or precipitates.

Checks in payment for gold received by the mint in San Francisco will be mailed out three days after receipt of shipment providing the forms accompanying the shipment are properly filled out.

All shipments must be fully prepaid, and the postage on letters enclosing forms must be fully prepaid. If uncertain of weights state that same are approximate and that the mint scales weight will be acceptable.

All forms may be had on application to the mint at San Francisco, or any other U. S. assay office.

Aside from the U. S. mint, there are about 200 private gold buyers licensed by the State Mineralogist scattered throughout the state who buy gold, or accept it in trade for merchandise. These private buyers, of course, do not pay the fine-gold mint price, as they must pay the cost of shipping, insurance and melting charges; but as they will purchase smaller amounts, and the time and trouble of shipping to the mint is avoided, it is often advantageous to dispose of it through them.

The names and addresses of licensed gold buyers (May, 1934) are listed below by counties:

Alameda:
- Henry R. Butler, 5656 Miles Ave., Oakland.
- Frank Kepka, 901 Broadway, Oakland.
- Robert E. Lamberson, 148 12th St., Oakland.
- W. H. Morrison, 88 Shattuck Square, Berkeley.
- Chas. Riskin, 1552 Broadway, Oakland.
- H. Riskin, 1025½ Broadway, Oakland.
- Myron Riskin, 1132 Broadway, Oakland.
- Nathan Z. Riskin, 1804 Telegraph Ave., Oakland.
- R. W. Schumacker, 693 Santa Rey Ave., Oakland.

Amador:
- Amador Metals, Reduction Co., Jackson.
- Bank of Amador, Jackson.
- Levaggi Estate Co., Plymouth.
- S. G. McKesson, 8 Broadway, Jackson.
- Frank W. McQuiston, Jackson.
- E. O. Miller, Jackson.
- G. & M. Roos, Plymouth.

Butte County:
- Henry C. Conger, Bangor.
- Cox & Frederick, 310 Broadway, Chico.
- J. Irving Bedford, 316 Main St., Chico.
- The Appleton Mining and Refining Co., Coutolenc.
- Geo. W. Zetzeche, 1863 Montgomery, Oroville.
- D. V. Vinton, Route 1, Oroville.
- First National Bank of Oroville, Oroville.
- Guy Bain, Box 124, Oroville.
- Chin Wing He, 1215 Lincoln St., Oroville.
- Chas. M. Davis, Paradise.
- Lester Z. Mitchell, Stirling City.

Calaveras:
- D. J. Smith, Angels Camp.
- Giacome Oneto, Angels Camp.
- Frank Genochio, Camanche.
- D. Potter, P. O. Box 119, Mokelumne Hill.
- A. Domenghini, Mt. Ranch.
- Treat Bros., San Andreas.

Del Norte:
- J. L. Musick, Crescent City.

El Dorado:
- Geo. O. Pontious, Coloma.
- Jerome C. Ackley, Georgetown.
- John Balderson, Georgetown.
- Robert J. Nelson, Georgetown.
- Mrs. Lottie Galleher, Lotus.
- Chas. F. Hines, Lotus.
- Richard W. Nance, Pilot Hill.
- Geo. L. H. Loram, 13 Center St., Placerville.
- N. H. Burger & Son, Placerville.
- Clara P. Fraser, Volcanoville.

Fresno:
- Arsen G. Alchian, c/o Federal Jewelry and Loan Co., 1826 Mariposa St., Fresno.
- Wm. H. Barnes, Auberry.
- Wm. W. Dunnicliff, Friant.
- Lewis H. Kahrt, Friant.
- N. Nielsen, 1206 Fulton St., Fresno.
- Wm. J. Noel, Orange Grove.
- Harry Rose, 1837 Mariposa, Fresno.
- Arthur H. Sienknecht, Star Route Box 5, Fresno.

Humboldt:
- Ernest J. Anderson, Orleans.
- A. Brizard, Arcata.
- Oscar F. Lowe, 2112 G St., Eureka.
- Rivers & Swan, Orleans.
- James C. Tario, 407 Fifth St., Eureka.

Imperial:
- M. L. Allen, Ogilby.

Madera:
  Wm. Krohn, Coarsegold.
  North Fork Supply Co., North Fork.
Kern County:
  Geoffrey C. W. Forge, Randsburg.
  Fay M. Howd, Randsburg.
  Tropico Mines Inc., Rosamond.
  John Norton, Cantil.
Los Angeles:
  Jere B. Stair, Azusa.
  Miller & Hopkins, 333 Centinela Blvd., Inglewood.
  Bronzamic Co., 1028 South Fir Ave., Inglewood.
  Ballard & Ballard, 315 West St., Los Angeles.
  James L. Bartlett, 3155 Hutchinson Ave., Los Angeles.
  L. A. Birchley, 217 N. Olive St., Los Angeles.
  E. H. Harrington, 306 West Third St., Los Angeles.
  Wm. J. A. Kelleher, 737 South Grand Ave., Los Angeles.
  National Gold Refiners, 311 Loew State Bldg., Los Angeles.
  Pacific Platinum Works, 814 South Spring St., Los Angeles.
  Geo. H. Pratt, 105 E. First St., Los Angeles.
  A. Riskin, 219 West Seventh St., Los Angeles.
  Edward C. Sewell, 1014 Towne Ave., Los Angeles.
  Morris P. Silver, 220 West Fifth St., Los Angeles.
  Gus Spieth, 8770 South Main St., Los Angeles.
  Joseph Zimmelman, 207 South Broadway, Los Angeles.
  L. S. Wood & Co., 622 South Lake St., Pasadena.
San Joaquin:
  James L. Robinson, 332 Wall St., Stockton.
  M. Friedberger & Co., 339 East Main St., Stockton.
Mariposa:
  Forney & Walsh, Bagby.
  W. L. Canova, Coulterville.
  Walter F. Hoppe, Coulterville.
  Walter D. McLean, Coulterville.
  Chas. Cavagnaro, Hornitos.
  Emile J. Trabucco, Mariposa.
  F. T. Schlageter, Mariposa.
  Elmo W. Eidson, Midpines.
  Frank Trabucco, Mt. Bullion.
Merced:
  R. C. Haun, 511 17th St., Merced.
Monterey:
  F. B. McDonald, 125 14th St., Pacific Grove.
Nevada:
  W. E. Moulton, French Corral.
  Geo. W. Fraser, 208 E. Main St., Grass Valley.
  Leon G. Beloud, 105 W. Main St., Grass Valley.
  Gilbert J. Ball, Jr., 311 Mills St., Grass Valley.
  West Mines Corp., Nevada City.
  Geo. A. Nihell, Nevada City.
  D. E. Barbieri, 115 Broad St., Nevada City.
  Don C. Billick, Nevada City.
  Fred Dunn, 211 Spring St., Nevada City.
  John J. Ghidotti, Nevada City.
  Henry H. Huckins, North San Juan.
Orange:
  Warren R. DuBois, 105 West Third St., Santa Ana.
Placer:
  Frank Murray, Alta.
  Robert E. Schields, Jr., Auburn.
  Chas. Yue, 291 Washington St., Auburn.
  W. F. Durfee, Auburn.
  Williams & Viscia, Colfax.
  William I. May, Colfax.
  Quinn Bros., Dutch Flat.
  Dorothy B. Meikle, Foresthill.
  Thomas E. Stanley, Gold Run.
  W. S. Macy, Iowa Hill.
  Michigan Bluff Merc. Co., Michigan Bluff.
  Herbert H. Coe, Sheridan.

Plumas:
- Coykendall & Morgenthaler, Belden.
- F. L. Miller, Greenville.
- Mrs. Maxwell & Son, La Porte.
- Quincy Drugstore, Quincy.
- Plumas County Bank, Quincy.
- Ada B. Mower, Rich.
- John S. Hussey, Box 243, Sloat.

Sacramento:
- S. L. Daken, Folsom.
- Norma Browning, 1716 H. St., Sacramento.
- Abe Gordon, 304 K St., Sacramento.
- David Harris, 501 K St., Sacramento.
- Samuel Marksamer, 730 K St., Sacramento.
- Geo. W. Peltier, 1014 8th St., Sacramento.
- W. F. Techow, 620 I St., Sacramento.

San Bernardino:
- Brand & Ellis, Oro Grande.

San Francisco:
- American Smelting & Refining Co., 405 Montgomery St.
- Anglo California National Bank, 1 Sansome St.
- Bank of America N. T. & S. A., 1 Powell St.
- Bank of America of Calif., 1 Powell St.
- J. R. Blum, Room 514 Crocker First National Bank.
- Joseph W. Goldstein, 7 Fourth St.
- S. B. Gracier, 212 Stockton St.
- Robert L. Hussey, 209 California St.
- Berthold Lissner, 1980 Washington St.
- Ore, Metal and Engineering Corp., 112 Market St.
- G. R. Randolph, 833 Market St.
- Solomon Riskin, 419 Kearny St.
- Albert S. Samuels, 879 Market St.
- Stamper & Smith, 94 Fourth St.
- Dirk Pieter Van Nounuys, 260 California St.
- Wells Fargo Bank and Union Trust Co.
- Western Gold and Platinum Works, 589 Bryant St.
- Wildberg Bros., 742 Market St.
- George Zwillinger, 717 Market St.

Santa Clara:
- Harry Hirsh, 190 S. First St., San Jose.
- Dan Levin, 104 S. First St., San Jose.

Santa Cruz:
- Richard Kay, 249 Soquel Ave., Santa Cruz.

Shasta:
- Northern California National Bank, Redding.
- Quirk & Boyd, Redding.
- Adolph F. Dobrowsky, 1556 Market St., Redding.
- Earl Hinnant, 1027 West St., Redding.
- McCormick Saeltzer Inc., Redding.
- William J. Morrison, Redding.
- Chester Vergnes, Schilling.

Sierra:
- Antonio J. Costa, Downieville.
- Henry H. Meyer, Downieville.

Siskiyou:
- Chas. Farrington, Callahan.
- John O. McBroom, Cecilville.
- Bennett Co., Forks of Salmon.
- Wm. Werst, Fort Jones.
- Scott Valley Bank, Fort Jones.
- John B. Johnston, Hamburg.
- Fred F. Wilson, Happy Camp.
- Henry D. Maltis, Happy Camp.
- Evans Mercantile Store, Happy Camp.
- Eliza Elliott, Happy Camp.
- T. Jones Co., Hornbrook.
- John Parc, Horse Creek.
- W. R. George, Sawyers Bar.
- H. H. Douglas, Sawyers Bar.
- L. H. Cornell, Seiad Valley.

Carl Langford, Somes Bar.
Judson G. Goble, Yreka.
Henry J. Barton, Yreka.
Gustave Dunn, Yreka.
O. J. Severn, 211 Miner St., Yreka.
Mrs. Ralph H. Lake, Yreka.
First National Bank in Yreka, Yreka.
Floyd C. Bartlett, Yreka.

Stanislaus:
Robert G. W. Hunter, Knights Ferry.
Walter P. Shoemake, 1029 Eye St., Modesto.
Ed. E. Wood, 1024 Eye St., Modesto.

Trinity:
Arabella E. Beerbower, Burnt Ranch.
James G. King, Del Loma.
Grover H. Ladd, Denny.
Andy Norgaar, Hayfork.
Frank A. Taylor, Hayfork.
Paulsen Bros., Lewiston.
Raymond E. Tapie, Trinity Center.
Sam Lee Co., Weaverville.
Weaverville Supply Co., Weaverville.

Tuolumne:
John Nicolini, Chinese Camp.
Alonzo Elsbree, Sonora.
John Ghiorso, Sonora.
James P. McCormick, 105 Linaberg St., Sonora.
Francis A. Panchott, 804 Washington St., Sonora.
Sonora Mining & Mill Co., Sonora.
M. F. Swerer, Jamestown.

Yolo:
Arena Prieta Co., 446 Third St., Woodland.

Yuba:
J. Merriam & Son, Dobbins.
F. G. Mooney Co., 422 D St., Marysville.
Henry M. Roher, Bellhaven Ranch, Rt. 3, Marysville.
Heney & Poole, 228 D St., Marysville.
Alfred A. Kneebone, Smartsville. (Buys gold at Bridgeport Resort, Nevada Co.)
W. C. Maupin, Smartsville.
S. M. Bunnell, Smartsville.
John A. Bean, Strawberry Valley.
E. V. Arnold, Wheatland.
Lloyd C. Nightingale, Wheatland.

Platinum

Pure platinum does not occur in nature. The tin-white malleable metallic grains and flakes that are nonmagnetic and insoluble in any single acid, which occur in some placer deposits and lag behind the gold in panning, are properly referred to as 'crude platinum.' The 'crude' metal is an alloy containing varying percentages of platinum, iridium, osmium, traces of palladium, rhodium, and ruthenium, usually some gold, a little iron and sometimes copper and nickel. Most of the crude platinum found in California will not carry over 65% platinum. Iridium is the most valuable of the platinum-group metals. It is harder and heavier than platinum and when it forms a considerable part of the crude metal the grains are sharper and more angular than the softer, purer platinum. If there is much iron in the crude platinum, it becomes magnetic and the use of a magnet to remove magnetite (black sand) would result in also picking up such platinum.

The returns received from the sale of crude platinum are usually disappointing to the miner and have caused much complaint, perhaps sometimes justified. It must be borne in mind, however, that the published quotations for platinum, iridium, osmium, etc., are for the separate, refined metals, and they do not apply to the crude material. This is well illustrated by the fact that although the quoted price of platinum was $40 per ounce, the average price of Colombian (South America) crude, basis 85% platinum for the month of January, 1932, was $29.55 per ounce. Neither does the 'official' price quoted by the leading interest (agents for Russian platinum) mean that all sales are necessarily at that figure. Cash transactions between dealers are frequently made at a figure several dollars less per ounce. At present (April, 1934) the platinum group metals are quoted as follows:

Iridium, per ounce, $60–$65, for 98–99% sponge and powder.
Palladium, per ounce, $23–$24.
Platinum, per ounce, $38 (official price of leading interest).
Osmium, per ounce, $60–$70.
Rhodium, per ounce, $50–$55.
Ruthenium, per ounce, $40–$45.

Based on these prices the actual value of the 'crude platinum,' if all the metals are paid for, would depend upon the percentage of each in the crude metal, less the cost of separating and refining them. Therefore, two different lots of 'crude patinum' of similar appearance may vary greatly in true value, although the miner may not realize why this is so. With refined platinum selling at $38, 'crude' platinum would probably not bring over $28–$32 an ounce.

Another factor complicating the price is that the seller must depend in nearly every case upon the buyer's own weights and analyses of the shipment, as the former seldom has means of checking them. The complete separation of the different platinum-group metals is a long and tedious chemical process and some platinum buyers do not make a separation of the osmium and iridium, simply estimating it as osmiridium, and neglecting the other elements.

There seems to be no simple or practical means for the small producer to overcome these marketing difficulties, and about the only choice that remains is for him to try various buyers until one is found whom he feels is fair in his dealings. The regular shipper will probably find the most satisfactory market among the larger platinum refiners and manufacturers of platinum wares in the east, but it may be equally satisfactory for the small and irregular producer to sell to some local buyer at a price somewhat approximating its actual value.

In general, well-established firms buying crude platinum are probably more just in their dealings with the miner than they are given credit for, it being hard for the seller not to overestimate the value of his product.

Among the buyers of platinum are the following:

Baker & Co., Inc., 54 Austin St., Newark, N. J.
J. Bishop & Co., Malvern, Pa.
American Platinum Works, N. J. R. R. Ave., at Oliver St., Newark, N. J.
Handy & Harman, 57 William St., New York.
Goldsmith Bros., Smelting and Refining Co., 29 E. Madison St., Chicago, Ill.
Platinum Metals Corp., 261 Fifth Ave., New York.
Irvington Smelting and Refining Works, Irvington, N. J.
Wildberg Bros. Smelting and Refining Co., 742 Market St., San Francisco, California.

S. S. White Dental Co., Philadelphia, Pa.

Western Gold and Platinum Works, 589 Bryant St., San Francisco, California.

S. B. Gracier & Sons, 212 Stockton St., San Francisco, California.

Shreve & Co., Bryant and Zoe Sts., San Francisco, California.

Geo. R. Randolph, 833 Market St., San Francisco, California.

Pacific Platinum Works, 814 S. Spring St., Los Angeles, California.

Black Sand

At nearly every placer property where sluicing is employed, there is an accumulation of black sand, containing a little fine gold and occasionally platinum. The rather tedious process of separating the precious metals from the worthless sand, without special equipment, has resulted in many inquiries for a market for the 'black sand.'

During the past several years a half-dozen or more individuals and companies, both local and in the east, have advised the Division of Mines that they had plants or processes for handling such material and that they would buy it in large or small lots. However, prospective shippers, who have approached these reputed buyers report that in nearly every case these parties have not been able, financially or otherwise, to fulfill their promises. Some sought aid in building their plant, others failed to reply to letters or acknowledge receipt of samples, so that on the whole little progress has been made in finding a market.

The Selby Smelter of the American Smelting and Refining Company, Selby, California, general office, 405 Montgomery St., San Francisco, probably furnishes one of the most definite outlets. This company purchases black-sand concentrates on the same basis as other gold ores. They do not pay for any platinum that may be present.

Western Gold and Platinum Works, 589 Bryant St., San Francisco, also purchase black-sand concentrates having a value of $100 a ton and up.

Apparently there is an opportunity for a small plant to do a legitimate business buying relatively low-grade black-sand concentrates, but up to the present time this field does not seem to be filled. The widely scattered localities from which the material comes and the number of small producers adds to the difficulty of placing such a project on a reliable and steady basis.

Very rich black-sand concentrates that have been 'cleaned' by the removal of all of the magnetite, chromite, and other worthless minerals may be sold to those listed as platinum and gold buyers.

Those who wish to investigate other possible markets for their black sand are referred to the following who may or may not provide an outlet but who have stated that they were buyers. No shipments should be made to these parties without first consulting them.

Regent Chemical Co., 317 Hamilton Ave., Brooklyn, N. Y.

Wilson's Black Sand Plant, Happy Camp, California.

Metalloy Co., 230 Park Ave., New York, N. Y.

James D. McLean, P. O. Box 446, Auburn, California.

W. R. Woock, Auburn, California.

H. W. Steffen, Sierra Machine Co., Inc., 201 12th St., Oakland, California.

PLACER MINING AREAS IN CALIFORNIA

One of the most frequent questions asked is ''Where is the best place to go?'' It is impossible to answer this question. Two parties working at opposite ends on the same river bar, though perhaps only 100 yards apart, might be getting entirely different results. All that can be done within the scope of this paper is to give the general areas in which placer mining operations are apt to be most remunerative. These areas are shown on the outline map of the State herewith and they are briefly described under county headings.

There is no agency, either public or private, having a complete list of public lands open to mining location, nor are there any maps available showing what lands are vacant. Under the mining laws mining claims may be taken up on vacant U. S. land and held indefinitely by doing the required annual assessment work. Notices of these mining locations are filed in the office of the county recorder for the county in which the land lies. There is no provision of law for filing such location notices with the U. S. Land Office. The result is that much of the land which appears on the U. S. Land Office records as vacant, is actually held under private ownership as mining claims. After examining the land the intended locator should learn the section, township and range and then examine the U. S. Land Office records, and the county recorder's and county assessor's books and plats. These records and actual notices and monuments on the ground are the only guides. U. S. Land Offices are located in Sacramento and Los Angeles, and the U. S. Public Survey Office in Glendale.

The most important gold mining section of the State is that extending along the western slope of the Sierra Nevada. Generally speaking the most favorable section begins on the west, where the main streams leave their deep canyons to enter the valley, and extends up stream to elevations of about 5000 feet. The upper reaches of the Feather and American rivers are an exception, the Middle Fork of the American and the branches of the Feather being gold-bearing nearly to their sources. The granitic area forming the core and crest of the Sierra Nevada is unfavorable.

The area indicated in the northwestern part of the State is also an important placer mining field and the acreage of vacant land with mineral possibilities is large because of the sparse population, and relative inaccessibility.

The lower courses of rivers easily reached by automobile have been worked over time and again. The gold recovered is mostly that which was lost from earlier mining. It is brought down the streams annually during high water and is deposited along the banks in a thin layer of sand and gravel at favorable places where the stream makes a bend or forms a gravel bar. It seldom pays to work such ground over a foot in depth.

The person who really wants to make his work remunerative should go prepared to travel on foot up the less accessible tributaries which empty into the river. A good county map, Forest Service map (if in a Forest Reserve), U. S. Geological Survey topographic map or other large scale map should be obtained.

The principal localities from north to south are:

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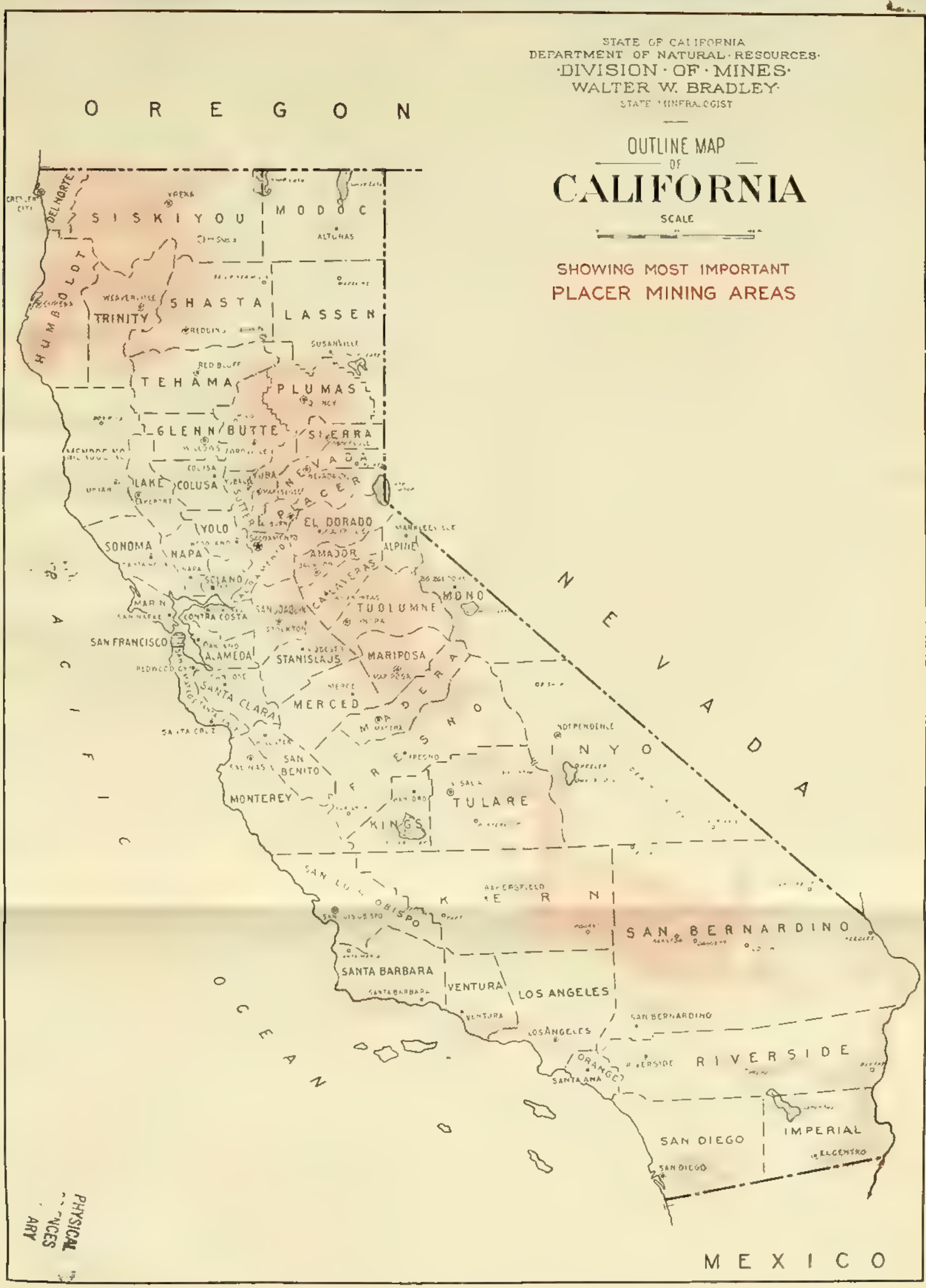

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE

SHOWING MOST IMPORTANT
PLACER MINING AREAS

OREGON
NEVADA
MEXICO
PACIFIC OCEAN
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
GLENN
BUTTE
SIERRA
MENDOCINO
LAKE
COLUSA
YUBA
NEVADA
PLACER
SUTTER
EL DORADO
YOLO
SONOMA
NAPA
AMADOR
ALPINE
SOLANO
CALAVERAS
MONO
MARIN
CONTRA COSTA
SAN JOAQUIN
TUOLUMNE
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN MATEO
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
FRESNO
INYO
SAN BENITO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
CRESCENT CITY
YREKA
ALTURAS
WEAVERVILLE
REDDING
SUSANVILLE
RED BLUFF
QUINCY
WILLOWS
OROVILLE
DOWNIEVILLE
COLUSA
NEVADA CITY
UKIAH
LAKEPORT
MARYSVILLE
PLACERVILLE
SACRAMENTO
MARKLEEVILLE
SANTA ROSA
NAPA
JACKSON
SAN ANDREAS
SAN RAFAEL
STOCKTON
SONORA
OAKLAND
MODESTO
MARIPOSA
REDWOOD CITY
SAN JOSE
MERCED
SANTA CRUZ
MADERA
INDEPENDENCE
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FRESNO
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HANFORD
BAKERSFIELD
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NORTHERN CALIFORNIA

Del Norte County. Black sands of present beach and lagoons and old elevated beach deposits; Smith River with its North, Middle and South forks and tributary creeks; also high gravel deposits at elevations of 2000 feet or more in French Hill, Big Flat and Bald Hill districts; reached by way of Crescent City.

Siskiyou County. Klamath River from Hornbrook to Somes Bar; Scott River; Salmon River and its forks and all tributaries of these rivers; reached through Hornbrook, Yreka, Fort Jones and Callahan, on the east, and Orick, on the west. Also Elliott Creek district through Jacksonville, Oregon. Many high terrace or bench gravel deposits are found along the rivers.

Humboldt County. Beach and lagoons mainly north of Eureka, Klamath, Trinity, Mad and Little rivers and creeks mainly in northeastern portion of county; reached from Eureka, Arcata and Orick on the west.

Trinity County. Trinity River and its forks, New River, Hayfork River, Reading, Deadwood, Coffin, Canyon and other creeks mainly in the northern half of the county. Many high bench deposits occur along the main streams; reached from Red Bluff and Redding on the east to Weaverville and from Fortuna and Arcata on the Redwood highway.

Shasta County. Sacramento River and Clear Creek, Cottonwood Creek, Beegum Creek and other branch streams flowing in from the west. Redding and Red Bluff are supply centers.

Butte County. The North, Middle and South forks of Feather River and their tributaries; Big and Little Butte and other creeks; reached via Oroville and Chico.

Plumas County. The North, Middle and South forks of Feather River to their source and all branch streams and creeks; reached from Oroville, or via Quincy.

Yuba County. North and Middle forks of Yuba River; Bear River, Honcut, Canyon and other creeks; reached from Marysville and Nevada City.

Sierra County. North and middle forks of Yuba River and their tributaries; Slate Creek, Big Canyon Creek, Oregon Creek, Kanaka and others; reached from Downieville and Sierra City, via Nevada City.

Nevada County. Middle and South forks of Yuba River; Deer Creek, Bear River, and creeks flowing into Bear River; reached from Lincoln, Marysville, Auburn, Grass Valley and Nevada City.

Placer County. Bear River, American River, its North and Middle forks, Rubicon River and other tributaries; reached from Lincoln, Auburn and Colfax.

El Dorado County. Middle and South forks of American River, Cosumnes River and its forks and tributary creeks; reached by way of Folsom, Auburn, Plymouth and Placerville.

Amador County. Cosumnes and Mokelumne rivers; Dry, Sutter, Jackson, and other creeks; reached by way of Plymouth, Ione and Jackson.

Calaveras County. Mokelumne, Calaveras and Stanislaus rivers and their branches; reached by way of Lodi, Jackson, San Andreas, Angels Camp and Sonora.

Tuolumne County. Stanislaus River and its forks, Tuolumne River and tributary streams; reached by way of Oakdale, Knights Ferry, Sonora and Groveland. Also include Stanislaus River above Oakdale, and Tuolumne River above Waterford in Stanislaus County.

Mariposa County. Merced River and its branches, Bear Creek, Mariposa Creek and Chowchilla River; reached by way of Merced, Snelling, La Grange, Coulterville, Bagby, and Mariposa.

Madera County. Chowchilla, Fresno and San Joaquin rivers and tributaries; reached by way of Madera, Fresno, Friant, and Coarsegold.

Fresno County. San Joaquin and Kings rivers; reached from Fresno, Friant, and Sanger.

Tulare County. Kaweah and White rivers; reached from Visalia and Porterville. Very limited areas.

SOUTHERN CALIFORNIA

In the region south of Tehachipi Pass and extending to the Mexican border, semi-dry- and dry-washing methods of working placer deposits are used generally on account of the scarcity of water.

A list of the areas in which this work has been done in the past, together with a brief description of some of the more important developments, is given below.[1]

Imperial County

The most productive deposits are known as the Mesquite, Picacho and Potholes. These are dry placers, although the Picacho deposits extend eastwardly, almost to the Colorado River. The gold in these districts came from the quartz stringers in the schists and slates of the Cargo Muchacho and Chocolate ranges of mountains, being brought down and concentrated in the gulches and washes by erosion.

Mesquite Placers are located 6 miles north of Ogilby and in the area east toward the Chocolate Mountains.

A number of dry washers have been working in these deposits recently. No reliable information as to the values recovered is available but sales of gold in small amounts are being made.

Picacho Placers. These deposits extend some 6 miles in an east-west direction, from a point about thirty miles north of Yuma and from two to five miles south of the Colorado River.

In the past much dry washing has been done and there are now several small dry washers in operation in this area.

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[1] Abstract from "Placers of Southern California," by R. J. Sampson, Supplement to Mining in California, April, 1932, Quarterly Chapter of State Mineralogist's Report XXVIII.

Potholes Placers are situated 10 miles northeast of Yuma and several miles west of Laguna Dam. This district has reported production of $2,000,000 which, it is stated, was recovered by dry washing, some four hundred or five hundred Mexicans having been at work for several years, in the past. At present a few small dry washers are being operated on these deposits.

Inyo County

Mazourka Canyon Placers, situated on the west slope of the Inyo Mountains, east of Independence, have been practically worked out by dry washers.

Kern County

Black Mountain and Grubstake Dry Placers are on the south slope of Black Mountain, near the head of Last Chance Canyon, about 13 miles northeast of Cantil. These have long been worked with dry washers. Several of these machines are now in operation and variable reports have been circulated as to their success.

Goler Placers. These deposits occur on the south slope of the El Paso range of mountains, in Goler Canyon and the gulches tributary to it. They are 25 miles northeast of Mojave and 10 miles west of Randsburg. On the hillsides they consist largely of alluvium with some rounded gravel, evidently deposited by intermittent streams, while in the main washes the rounded gravel is in excess. Haley[1] mentions a short channel which came in through Red Rock Canyon where it was joined by another from the west, by way of Jawbone Canyon. He states that the shore line can be traced through by way of Goler and Summit Diggings and through Coolgardie, but dips under the wash near Barstow.

Kern River Placers. These deposits are distributed along the river from Democrat Hot Springs, 13 miles south of Isabella to Hobo Hot Springs, a distance of 12 miles.

The gold is contained in the alluvium of the slopes on each side of the river, also a few small gravel benches, and in the crevices and underneath large boulders in the stream bed itself. A small dredge has been operated in the river valley at Keyesville.

In the past eighteen months, some small suction pumps have been used to raise gravel from the bottom of the river and from around the base of the large boulders, while for many years intermittent operations in the crevices of the river bedrock have been carried on in a small way.

Piute and Greenhorn Mountain Deposits. There are small amounts of gravel in the gulches of the Piute and Greenhorn Mountains. Some washing in a small way has been done here in the past.

Randsburg or Norden Placer is in Sec. 22, T. 29 S., R. 40 E., about 2 miles north of Randsburg and the north base of the Rand Mountains.

Sixteen shafts, ranging from 15 to 34 feet in depth were sunk in this area. Eleven of them reached bedrock. Reported values from 250 yards of material taken from these shafts gave 80 cents per yard for 4′ to 16′ of overburden, and $2 per yard for the underlying gravels which average 12′ in thickness.

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[1] Haley, Chas. S., Calif. State Min. Bureau, Bull. 92, p. 156.

The gravels are unassorted, containing many large boulders. They are tightly packed and locally cemented with 'caliche.' The bedrock is schist.

The gold recovered is worth $18.48 per ounce (at the old base price). The average size is such that ten colors yield a value of one cent. Pieces having values as high as 20 cents were obtained in the sampling. It is not confined to definite horizons but is rather evenly distributed throughout the gravel.

In 1923, a dredge having a capacity of 500 to 750 yards per day was installed in a 40′ by 50′ hole made for the purpose. Water was purchased from the Yellow Aster Mining Company at $1.25 per 1000 gallons, but sufficient water could not be put into the hole to float the dredge.

In 1932 a Pierce Gold Dredge (dry land dredge) was operated here for a brief period and then moved to Benson's Gulch in the Goler area.

Nieto and Feldham Group of Claims, consisting of 3 claims, is in the Atolia District, in Sec. 30, T. 30 S., R. 41 E., M. D. M., and comprises 320 acres.

This deposit was primarily worked for tungsten and is a part of the 'Spud Patch.' Sampling is reported to show that bedrock is at a depth of from 15′ to 18′ and that in addition to the scheelite the alluvium contains from 75 cents to $1 per yard in gold. These values occur in alluvium of comparatively recent age, the deeper alluvium having been found barren in a 250′ shaft which was sunk just southeast.

The following plant was used for running the samples taken:

Fordson tractor engine, chain drive to double drum dragline hoist; to 3″ grizzly; chain bucket elevator to 25-ton bin; belt to 2′ by 6′ double deck trommel, ½″ and 8-mesh; screenings to 12″ Ainlay Bowl Gold Saver; to 2 sets of shaking sluices, each 3′–4′ wide by 6′ long, made of 16-gauge sheet steel; tails to dewatering drag belt and belt tailings stacker. Recovered water is pumped to 6′ Allen Cone by 1½″ centrifugal pump; clear water overflow to fresh water tank. This plant is run by 15-h.p. International gas engine.

Red Rock Canyon Placers. These deposits occur in Iron Canyon and its tributaries. This canyon is tributary to Red Rock Canyon from the northeast.

Ricardo Placer Mines, comprising 3000 acres of patented placer claims, are situated on both sides of Iron Canyon about 25 miles north of the town of Mojave.

These deposits extend along the hills on each side of Iron Canyon for several miles. The formation consists of a series of beds of conglomerate sandstone and lava flows. The conglomerates at the base of these hills are free from volcanic pebbles but consist of many kinds of rock, some of which are foreign to the district. The richest gulch, worked during 1894–1896, was known as Bonanza and is two miles east of Ricardo. The gold was found not only in the gulch but on the slopes of the hills above. These diggings were worked by dry washers. In more recent years many attempts have been made to sink to bedrock in Iron Canyon but all have failed due to excessive water flow.

Summit Diggings. These deposits occur at the foot of the south slope of Summit range of mountains, 6 miles east of Goler and 6 miles north of Randsburg. They are described under the names of the two principal operations.

Oro Fino Placer (now Olympic and Miller groups) consists of 160 acres in Kern County and 30 acres in San Bernardino County, just east of Owenyo branch of the Southern Pacific Railroad, 6 miles north of Randsburg.

This property has been worked intermittently for thirty years and several hundred feet of tunnels have been driven on bedrock, the gravels having been worked in dry washers.

The unassorted gravels, containing many boulders, are widespread and not related to recent streams. They are stated to average 18 feet in thickness and are compact but only lightly cemented. Of this thickness only about 6 feet immediately above bedrock has been taken in most of the past operations. The gold is fairly coarse, showing pieces up to $4.25 in value.

Summit Gold Placers comprising 1640 acres in Secs. 1 and 12, T. 29 S., R. 40 E., and Sec. 6, T. 29 S., R. 41 E., M. D. M., 6 miles east of Goler and 6 miles north of Randsburg.

The gravels consist of reconcentration of the older alluvium in recent water courses. They are unassorted, varying from 2 to 10 feet in thickness and containing many large boulders. The values occur uniformly distributed throughout the gravel. The gold is fairly coarse. Samples from test holes are reported to carry from 35 cents to $1 per cubic yard. Large scale operations here were abandoned after the treatment of several thousand yards. It was reported that recovery of the gold was difficult due to the large amount of black sand in the gravel.

Recent operations have been confined to a few individuals who are operating dry washers on the gravels above and to the east of the shovel cut made by the former operators.

Los Angeles County

Gold[1] was first discovered in Los Angeles County in 1834 and the placers of San Francisquito, Placerita, Casteca, Palomas and Santa Felicia canyons were worked between the years of 1834–1838 by the priests of the San Fernando and San Buena Ventura missions. The placers of San Gabriel Canyon were worked by the priests of San Gabriel Mission and native Californians until the discovery of gold by Marshall in 1848 at Sutter's Mill.

Placerita Canyon Deposits occur 12 to 15 miles northwest of Newhall. For these deposits see State Mineralogist's Report IX, pp. 200–203.

San Francisquito and Bouquet Canyon Deposits (see State Mineralogist's Report XI, p. 248) are situated north of Saugus. These deposits have been the scene of much activity due largely to their proximity to Los Angeles and the unemployment situation of the past three years. The rush of water unleashed by the failure of the St. Francis dam eroded the sides of the canyon, depositing thousands of tons of angular gravel and a little gold in the creek bed. The discovery of this gold caused some excitement and has resulted in numerous people attempting to wash the gravels of the present stream, as well as some bench gravels on the hillside above.

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[1] Rept. XXIII of the State Mineralogist, p. 291.

San Gabriel Placers. These deposits occur primarily as high gravel benches on each side of the canyon, scattered over a length of several miles. The auriferous gravel in the canyon itself is probably a reconcentration of these bench gravels by recent streams.

In the past year or so there has been much activity here in a small way.

Bibl: State Mineralogist's report VIII, p. 340; Bull. 92, pp. 154–155.

Temescal Ranch Deposit, comprising some 3000 acres, lies between Devils Canyon on the northwest, Palomas Canyon on the northeast and Santa Felicia Canyon on the east and south. It is contained in an area of some six square miles. It is 14 miles northeast of the town of Piru, the greater portion of it is in Los Angeles County.

This is a most extensive deposit. The sand, gravel and sandy clay appear to form a crescent-shaped range of hills which parallel Devil's Canyon almost to its head and there swings southeast along the southwest side of Palomas Canyon. For a distance of 3½ miles along Devils Canyon these hills which are yellowish-brown in color, predominate, although occasionally the underlying Tertiary gray clays have been exposed by erosion. To the southeast all of the exposed country consists of Tertiary clays, while to the northeast, Violin Canyon is flanked by a red granitic mountain.

These hills have been cut deeply by Devils Creek and other smaller streams. In places they rise in almost sheer cliffs for 300 feet before breaking to a more gradual slope, rising to a total height of between 600 and 700 feet above the bottom of Devils Canyon. The average thickness of the gravel beds is reported to have been estimated by engineers as 300 feet. The material consists of sand, sandy clay and sub-angular to rounded gravel. (It was probably deposited here by some ancient stream which flowed through the Mt. Pinos and Frazier Mountain country in a southeasterly direction.)

In Mine Creek about one mile above its mouth several tunnels, aggregating about 1000 feet in length, have been driven into these deposits. Apparently it was too low grade to be profitably worked by this method. No other operations have here been attempted, although preliminary plans for hydraulic mining on a large scale have been made.

Canyon Placer Mine, comprising 640 acres, is located along Texas Canyon 2 miles northeast of Texas Canyon Mine and 12.8 miles northeast of Saugus.

The auriferous gravel deposits are on the north side of the canyon and their general course is northeast, being one-quarter of a mile wide and two miles in length.

In 1927 a high bench was being worked. Water was secured from a dam in Texas Canyon one mile above the workings. The gravel was 8 to 10 feet thick here. The gravel was shoveled into a sluice from which it passed through a revolving drum, then onto a fine screen before going to a large rocker driven by a 3-h.p. gas engine. The gold recovered was quite fine and due to limited water supply could only be worked during the winter months.

Texas Canyon Placer Mine, comprising Texas and Woodrow Group of claims, consisting of 320 acres, is located in Texas Canyon 10 miles northeast of Saugus.

On the north side of the canyon a gravel bench some 6 to 8 feet thick has been worked for about a quarter of a mile in length. The channel has general northeast course. The gold is quite fine. The gravel is composed of metamorphic rocks and some quartz. Various attempts have been made to work the deposit by pumping water from the canyon. Work has been carried on intermittently due to scarcity of water.

Mono County

Conroy Ranch Placer comprises 400 acres of patented land located on the north shore of Mono Lake and to the west of Mono Diggings.

The gravel on this property is reported to carry 25 cents per yard and covers the whole area of the ranch. It is reported that the property was formerly drilled for dredging ground.

Dog Creek Placer, consisting of 280 acres, is on Dog Crek, in Secs. 2, 3, 11, 10 and 15, T. 3N., R. 25 E., and Secs. 34 and 35, T. 4 N., R. 25 E., M. D. M. 9 miles south of Bridgeport and 60 miles north of Laws.

This deposit was discovered in 1870 and had been intermittently worked until 1930 when it was acquired by present company.

Primary loose gravels on Dog Creek occur on a basaltic bedrock and the pay is contained in the 2 to 4 feet next to the bedrock. This pay gravel is buried under from 4 to 10 feet of secondary gravel.

Open cuts, pits and prospect shafts along the creek are reported to have exposed 2,000,000 cubic yards of gravel which carry average values of 50 cents per yard.

Virginia and Dog Creek Placers. These deposits, consisting of 440 acres, are in Secs. 2, 11 and 14, T. 3 N., R. 25 E., 60 miles north of Laws and 9 miles south of Bridgeport.

In the 18,000 feet of channel on this property the pay is contained in from 2 to 4 feet of gravel immediately above the basaltic and andesitic bedrock. This is overlain by from 6 to 10 feet of gravel which carries no values. This bedrock gravel shows from 15 to 20 colors to the pan, some of it being coarse, as large as wheat grains. Reported to carry from 50 cents to $2 per yard.

Area which has been worked by dragline is 150 feet long by 100 feet wide by 15 feet deep.

Walker River. Deposits of auriferous gravel occur in the head water area of Walker River near Bridgeport.

San Bernardino County

Coolgardie Placer Deposits are situated 15 miles north of Barstow. The nearest available water, in quantity, is some fifteen miles distant.

These deposits are in a broad desert valley and were evidently washed down from the granitic ranges to the north and by an ancient river which came in through Red Rock Canyon, by way of Summit Diggings and Goler.

Much dry washing has been done here since 1900.

Bibl: State Mineralogist's Report XV, p. 817; Bull. 92, p. 156.

Camp Rock Placers are in Sec. 28, T. 7 N., R. 3 E., in the Bessemer Mountains, 25 miles northeast of Box S ranch and 47 miles (by road) from Victorville.

This deposit is on the detrital slope at the foot of the Bessemer Mountains on the southwest side. These mountains consist entirely of granite. The drainage is to the southwest into a valley which also receives drainage from the southwest slope of the Ord Mountain A narrow drainage channel has been prospected for about 1000 feet of its length. The granitic bedrock appears to vary from 15 to 25 feet below the surface.

This work is reported to have been done in gravel which carried from $1 to $1.50 per yard.

Scarcity of water seems to have presented an insurmountable obstacle to operations.

Goldstone District is some 33 miles north of Barstow and about 18 miles north of Coolgardie. Erosion of the gold veins of this district has resulted in the deposition of auriferous alluvium and gravels in the gulches. Some dry washing was done here in the early part of this century.

Hamberger Placers are located 15 miles east of Atolia. This ground is all owned by private interests.

Holcomb Valley Placers lie principally in T. 3 N., R. 1 and 2 E., S. B. M. The deposits are near the top of the San Bernardino Mountains north of Bear Lake.

The gold bearing material is angular granite detritus containing very few washed or rounded stones. This 'gravel' is overlain by from 4 to 8 feet of light, loamy material, while the substratum contained more clay and was also richer in gold.

This was one of the early gold discoveries in the county, about 1860. In 1894 an English concern attempted operations on a large scale but apparently these operations did not pay.

Bibl: State Mineralogist's Report XV, pp. 798–799.

Old Woman Springs District is about 50 miles east of Victorville, just east of Lucerne Valley and in the vicinity of the Emerson Mine. It is known as the *Maumee Placer*.

Recent attempts to dry wash the alluvium and unassorted gravels of this area, on a large scale, apparently have failed.

Ventura County

Lockwood Valley Placers are about 50 miles northeast of Saugus and about 18 miles west of Gorman.

These gravel deposits border all the high peaks of crystalline rocks and are particularly extensive along the head of Piru Creek between Lockwood Valley and Rays Creek. The gold has undoubtedly been derived from the quartz veins in the schists nearby. Beginning about 2½ miles above the mouth of Lockwood Creek on the Piru are a series of terraced gravel deposits extending in a westerly direction to San Quelmo Canyon (about 15 miles) which are said to carry everywhere more or less gold. Desultory mining has been carried on here for many years. These gravels seem to have been deposited by an ancient stream which diverged from the present course of Piru Creek more toward Mt. Pinos. South of the Piru, at this point there are no gold-bearing gravels. Farther down the Piru the gulches which head in the Alamo Mountain also contain gold.

Bibl: State Mineralogist's Report XII, p. 494.

For further information regarding placer deposits in southern California, reference should be made to California State Mining Bureau Bulletin 92, Gold Placers of California; Bulletin 95, Geology and Ore Deposits of the Randsburg Quadrangle; and the State Mineralogist's Reports on the various counties.

MINING LAWS

Two bulletins are available on the mining laws. Bulletin No. 106 'Manner of Locating and Holding Mineral Claims in California' (with forms), a pamphlet of 20 pages covering the essential points, price 25 cents postpaid, and Bulletin No. 98, 'American Mining Law.' The latter is an elaborate treatise covering all phases of mining rights, yet concise and plain reading. It is a work of 811 pages printed on thin paper and bound in flexible leather, price $3.00, postage 15 cents. This subject will not be discussed, therefore, other than to cover briefly a few points frequently brought up.

License. In California no license of any kind is required to prospect on the public lands of the United States; locate mining claims, or mine on such land.

Citizenship. A valid location (claim) may be made without regard to age, sex, residence, or citizenship of the locator; but a patent can not be obtained by an alien.

Number of Claims. There is no limit to the number of locations (claims), either lode or placer, which the same locator or locators may make regardless of whether they are separate or adjoin or whether they are located at the same or different times, provided there is a valid disovery of mineral on each claim and that the land is public land open to location.

Witnesses. No witness is required on a location notice, but it may be witnessed, if desired.

Sunday. A mining claim located on a Sunday or other holiday is legal.

Forest Reserves. The National Forests, with a few exceptions, where certain withdrawals from entry are in effect, are open to prospecting and mining. Prospecting may be carried on and mineral locations may be made within the National Forests as on public lands outside their boundaries, where the land is shown to contain valuable deposits of mineral subject to entry under the general mining law.

Lands on which Federal funds have been expended for certain administrative purposes are automatically withdrawn from location and entry. This includes lands selected for ranger stations, public camp grounds, etc., which have been improved at the expense of the government.

Lands on which improvements have been placed by private individuals under special-use permit from the Forest Service are not subject to mineral location.

National Monuments. Mineral locations cannot be made in National Monuments. (Special rules apply in Death Valley National Monument.)

National Parks. No mining is permitted in National Parks.

Stock-raising Homesteads. These homesteads, taken up under the 640-acre Stock-raising Homestead Act passed in 1916, carry no mineral rights and whether patented or not are open to prospecting and the location of mining claims, with certain restrictions.

Every other form of patent carries mineral rights to any mineral found after the patent has been issued and therefore such patented lands are not open to mining location.

River Claims. The banks, bars and beds of nonnavigable rivers and streams are open to location and patent as mining claims where the opposite banks thereof have not passed into private ownership. Proprietors of land bordering on such streams own to the center of the stream, and if the land on both sides is privately owned, a claim cannot be located in the bed at that point. If public land on one side and private land on the other, a claim could be located on the public land side to the center or thread of the stream.

A mining claim cannot be located in the bed of a navigable river.

Beach Claims. The beach, termed in law 'tidelands,' and defined as ''land uncovered at low tide and covered with water at ordinary high tide,'' belongs to the State for a distance of three miles out. It is not ''mineral land of the public domain.'' Mining locations lying below the line of ordinary high tide are without authority of law, and, therefore, void. No title can be obtained to the beach, and mining operations carried on there can be stopped at any time by the proper authorities.

Railroad Land. Odd-numbered sections within a railroad grant, for which final patent has *not* been approved or granted, may be prospected and located for minerals the same as vacant government land, but the locator in such case should notify the U. S. Land Office at once as to the mineral character of the land and be prepared to protest or contest the railroad right to a patent. No mining rights can be obtained on *patented* railroad land except by lease, purchase or otherwise with the consent of the owner. The U. S. Land Office records will show what railroad lands are patented and what are not patented.

Indian Reservations. Certain Indian reservations are open to leasing but the terms are such as to deter the ordinary prospector. Details may be obtained from the Reservation Superintendent.

State Lands. Mining claims cannot be located on school land owned by the State (usually Secs. 16 and 36), but permission to prospect such lands with a preferential right to a mineral lease may be had from the State Department of Finance, Sacramento.

Water. The locator of a mining claim is entitled to use any water naturally flowing on or across his claim. Information in regard to appropriation of water for mining from a source outside the claim may be obtained from the State Division of Water Resources, Sacramento.

Salines, etc. Special laws exist for prospecting and leasing public land containing potassium compounds, sodium nitrates, phosphates, natural gas, asphaltic minerals and oil. Information regarding these may be obtained from the U. S. Land Office.

Hydraulic Mining, defined as ''mining by the means of the application of water under pressure through a nozzle against a natural bank'' may not be carried on within the drainage basin of the Sacramento and San Joaquin rivers except under permit of the California Debris Commission, 208 Post Office Building, Sacramento.

MINING CLAIMS

The following steps are necessary in order to properly locate and hold a mining claim under the laws of California and the United States.

(1) *Discovery.* In the case of a quartz or lode location there must be a discovery of valuable mineral in place within the limits of the claim. Detached pieces of ore or 'float' are not enough. In placer locations the valuable mineral occurs mixed with the soil, or in certain layers, which at times may be buried at some depth below the surface. No claim is completely secure without a mineral discovery.

(2) *A location notice* must be posted upon the claim. In the case of a quartz (or lode) location, this must be posted at the discovery point, and must contain the following: (a) The name of the claim. (b) The name of the locator or locators. (c) The number of linear feet claimed in length along the course of the vein, each way from the point of discovery, with the width on each side of the center of the claim, and the general course of the vein or lode, as near as possible. (d) Date of location. (e) Such a description of the claim by reference to some natural objects or permanent monument, as will identify the claim.

Any error in the original notice can later be corrected by posting and filing an amended one.

A quartz claim must not exceed 1500 feet in length along the course of the vein, nor 600 feet in width, and must not cover over 300 feet in width on each side of the vein measured from the center of the vein at right angles to its course or strike. The end lines should be parallel. Mill sites, containing not over five acres, are located in the same way as quartz claims, but only on nonmineral land.

In case of a placer claim, the location notice must show the name of the claim, the name of the locator or locators, date of location, number of acres claimed (if located according to the lines of the public survey) or the number of feet (if following the course of a stream) and such a description of the claim, by reference to some natural object or permanent monument, as will identify the claim; but if a placer claim is located according to the lines of the public survey, on land previously surveyed by the government, the description by legal subdivision will serve the purpose, and the claim need not be staked. A placer claim located by an individual cannot exceed 20 acres in area, but the number of such claims that may be located is not limited. An 'association placer' claim may contain from 40 acres (by two persons) to a maximum of 160 acres (by eight persons); 20 acres being included for each joint locator. A valid location, lode or placer, may be made by a male, or female citizen, a minor child, or an alien; but a *patent* cannot be obtained by an alien, as citizenship is required before a patent is issued.

(3) *Filing Notice.* A copy of the location notice must be filed for record with the county recorder of the county or counties in which the claim is located, within 30 days after posting on the claim.

(4) *Marking.* The discovery point and the corners of a quartz claim should be marked by stakes or monuments so that anyone coming on the claim can readily find what land is claimed. A placer claim which is not laid out according to the lines of the public survey must also be marked.

On unsurveyed land, a placer claim is preferably laid out with lines running north-south and east-west. An area 660′ x 1320′ contains 20 acres and corresponds to one-half of one-fourth of one-fourth of a section. Placer locations apply to all forms of deposits except veins of quartz or other rock in place carrying valuable mineral.

(5) *Annual Labor.* One hundred dollars must be expended annually for the year ending at noon of July first, upon or for the benefit of each claim, except for the fraction of a year between the date of location and noon of July first next following. For this work, an association placer claim containing over 20 acres is considered a single claim. The requirements may be satisfied by mining the mineral, running cuts, tunnels, or shafts to develop or outline the deposit, making necessary trails or roads or water ditches or installing mining machinery. On claims located as a group, the assessment work for all may be done on one claim if it can be shown that all the other claims will be benefited, as in the case where a tunnel is run into a hillside to prospect claims above the line of the tunnel.

(6) *Proof of Labor.* The proof of labor is an affidavit which should be made annually by the claim owner or by someone acting for him who is acquainted with the facts, setting forth that during the past year the sum required by law has been expended for assessment work for the benefit of the claim. This affidavit should be filed for record in the office of the county recorder within 30 days after July first.

FORMS

No particular form of printed location notice is required. If the proper information is given it may be written on a shingle and posted at the point of discovery, but it is much safer to use a regular form so that no essential matter will be omitted. These can be obtained at stationery stores handling legal forms and at most newspaper printing offices in mining districts.

The following are good examples.

Form of Placer Location Notice (on Surveyed Land)

Notice is hereby given that the undersigned has this ------ day of ------, 19--, located a placer mining claim situate on public surveyed land in ------ Mining District, County of ------, State of California, described as follows: The ------ of section ------, in township ------, range ------, M. D. M., containing ------ acres.

This claim shall be known as the ------ placer mining claim.

------, Locator.

Form of Placer Location Notice (on Unsurveyed Land)

Notice is hereby given that I, ------, have this ------ day of ------, 19--, located on public unsurveyed lands in the ------ Mining District, County of ------, State of California, a placer claim described as follows: Beginning at a (*tree, rock in place, stone, post or monument*) upon which is posted the notice of location, running thence (*north*) six hundred and sixty feet to a post marked ______, thence (*east*) thirteen hundred and twenty feet to a post marked ______, thence (*south*) six hundred and sixty feet to a post marked ______, thence (*west*) thirteen hundred and twenty feet to place of beginning.

All of said posts are at least (*four inches*) square by (*four*) feet (*six*) inches in length and set at least one foot in the ground and surrounded by a mound of stones, and containing twenty acres.

This location is situated about (*feet*) distant from (*name some natural object or permanent monument*).

The name of this claim is ______.

______, Locator.

Form of Lode Location Notice

Notice is hereby given that I, ______, do hereby locate and claim (*fifteen*) hundred linear feet of this vein or lode, together with surface ground extending (*three*) hundred feet in width on each side of the middle of said vein or lode and described as follows: Commencing at a stake set in a mound of stones where this notice is posted, which stake is at the point of discovery on said vein or lode and on the center line of this location, I hereby claim (*six*) hundred feet extending in a (*southwesterly*) direction along the course of said vein from point of discovery to stake at center of the (*southerly*) end line of this claim, and (*nine*) hundred feet in a (*northeasterly*) direction also extending from said point of discovery to a stake at center of the (*northerly*) end line of this location. The general course of the vein or lode is (*northeasterly*) and (*southwesterly*) as near as can be determined from present developments. The (*northerly*) end center stake is situated about ______ feet from (*name some natural object or permanent monument*) and thence this claim extends (*three*) hundred feet (*northwesterly*) to the (*northwest*) corner; thence (*southwesterly*) (*fifteen*) hundred feet to the (*southwest*) corner; thence (*southeasterly*) (*six*) hundred feet to the (*southeast*) corner; thence (*northeasterly*) (*fifteen*) hundred feet to the (*northeast*) corner; thence (*three*) hundred feet (*northwesterly*) to the (*northerly*) end center stake, the place of beginning.

The name of this claim is ______ and it is situated in ______ Mining District, County of ______, State of California.

______, Locator.

Note: (*No witnesses required.*)

Form of Mill Site Location Notice

Notice is hereby given that I, ______ proprietor of that certain vein or lode claim known as the ______ mining claim (*or the owner of that certain quartz mill or reduction works known as the* ______) has this ______ day of ______, 19__, located five acres of nonmineral land to be known as the ______ mill site, situate in ______ Mining District, County of ______, State of California, and described as follows: Commencing at a point from which (*name natural object or permanent monument*) bears ______, feet; thence (*south*) seven hundred and twenty-six feet; thence (*west*) three hundred feet; thence (*north*) seven hundred and twenty-six feet; thence (*east*) three hundred feet to the point of beginning.

The name of this mill site is ______.

______, Locator.

Form of Affidavit of Annual Labor

State of California} ss
County of________}

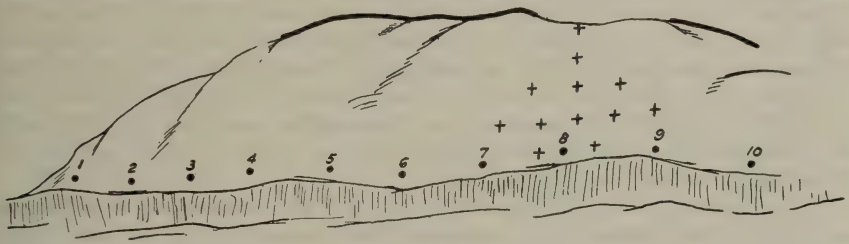
______, being first duly sworn, deposes and says, that at least (*one*) hundred dollars worth of labor was performed (*or improvements made*) between 12 o'clock noon of the first day of July, 19__, and 12 o'clock noon of the first day of July, 19__, upon the ______ mining claim situate in the ______ Mining District, County of ______, State of California. Such expenditure was made by or at the expense of ______, the owner of said claim, for the purpose of complying with the federal and Californian mining laws pertaining to annual assessment work.

Subscribed and sworn to before me this ______ day of ______, 19__. ______, Notary Public in and for the County of ______, State of California.

PROSPECTING FOR VEIN DEPOSITS[1]

To narrate an actual instance of a gold discovery and the procedure of the prospector in uncovering the orebody may be a convenient way of describing this fascinating work. Since 1929, hundreds of people in this state have made their first attempt to search for minerals. For those who care conscientiously to prospect in a mineralized section, there is exhilaration and possible gain to be had.

During most of the western gold booms of the past, much, if not most of the locating of a district was done by inexperienced people who, in a more or less panicky way, tried to see how much ground they could claim, and located any open land within a radius of five or ten miles of the original discovery. The idea in many cases was to obtain and sell the property at a high price; the close-in claims usually being the best sellers. Many such pieces of ground were purchased by wild-catters whose chief intention was to sell stock.



Prospecting a hillside. Beginning at lot No. 1 a sample was taken and thence every 50 or 100 ft. At point 8 the best prospect was found. Samples were then taken as represented by + until the crest of the hill was reached; in this case the vein was rich, but did not outcrop.

In the fall of 1905 when the boom was on in Goldfield, Nevada, and when that region was about two years old, Mr. J. R. Davis, a mining man, who understood prospecting, arrived in camp. The district was already located for miles around; some leasers were shipping high-grade ore, and the camp was all excitement.

Mr. Davis looked carefully over the district. He decided to prospect Sandstorm Hill, on the crest of which a large quartz vein outcropped. Cross-cut trenches had been made on this vein and many samples assayed. The outcrop was known to have a small gold content, as the assays usually showed a value ranging from a few cents to a dollar or so a ton, but as yet nothing worth while had been found.

Sandstorm is a low hill, rising about 200 feet above a dry, rocky gully or wash. Mr. Davis started at the foot of the lower end of this isolated hill just above the gulch, at a point where the over-burden had not been disturbed. With a shovel he removed the loose surface cover to a depth of a few inches, then took a full shovel of earth for a sample and placed it in a labeled bag. He then advanced along a contour-like line parallel to the edge of the gully for a distance of forty or fifty feet where a second sample was taken, and so on until a number had been obtained. He then went to his tub of water and panned each of these carefully, watching for any traces of gold. Most of these samples showed a trace of the yellow metal as might be expected in this section; but Mr. Davis was looking for tests that would show a slightly better prospect than these. He returned to his work of sampling and continued taking more at intervals of about fifty feet, just above the edge of the dry creek. A point was finally reached where the soil showed an increase in its gold content. This was the point where careful panning was now to be done. Here, samples were taken at twenty-foot spacings, and one of these was found to be richer than any of the others. Our prospector then proceeded up the hill about twenty feet above the point where his best find so far had been made and took samples at intervals of about twenty feet in a line parallel to the first. The best gold producing hole in this line was marked; up the hill about twenty feet more shovels of earth were taken to outline the boundary of the gold flow. In this way the hill was ascended on the fan-shaped area containing gold float, the source of which was on the top of the hill, a section of the quartz vein that did not outcrop—a depression rather than an exposure. A lease was obtained on the enriched part of the claim, and in five months it yielded $240,000.

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[1] Contributed by Frank Sanborn, Mineral Technologist, State Division of Mines.

The Loftus-Davis Lease on the Sandstorm was not the only gold deposit that Mr. Davis ever found. He has to his credit four more—small ones, but all were profitable.

In Siskiyou County, the old Schroeder and Warner Mine situated above the headwaters of McAdams Creek was another of the many producers found by prospecting according to a system. Mr. Schroeder, after watching the placer operations around Deadwood, decided to attempt to find the source of most of this gold that was being recovered from the creek. Accordingly, he set out with his gold-pan on a tracing expedition up Deadwood cañon. The branching cañons leading into Deadwood were tried and the branches showing the least amount of gold were eliminated. By this system of elimination the main gold float was traced until it suddenly diminished markedly at a point near the source of McAdams Creek. This disappearance of gold was an indication; so the gold seeker went back a short distance to investigate the hillsides by 'post-holing' as this particular method of sampling is often called. Loose gold was found on the hill and subsequently traced to its source. In this case the float was traced about five miles to its origin. It is stated a month or more was spent in the search. The Schroeder and Warner Mine is reputed to have produced several hundred thousand dollars.

The writer while at the Union Mine, near El Dorado, in El Dorado County, from 1915 to 1918, occasionally devoted a little time to prospecting the surface of these old mining claims, using a system similar to that of Mr. Davis. On one claim he had reason to believe a gold-bearing vein existed although there was no visible outcrop of quartz. After some systematic panning, colors were found, and shortly afterward the vein was uncovered. The orebody from whence the gold float came proved to be only about fifteen or twenty feet in length and from four to six inches wide, but as it was a well-defined vein having a gouge on one wall, the owners thought enough of its possibilities to install a headframe and sink a shaft to a depth of two hundred feet where drifts were run.

A second vein on another claim of the Union group was likewise found. Like the first, however, it was a small ore shoot and was abandoned after about a hundred feet of work had been done. It is true they did not prove profitable, but there were enough indications present to warrant some work whether they had been found in 1852 or 1917. These statements are made to show what is possible in many old mining districts as well as new ones.

The writer also found a small silver-lead prospect in the Monte Cristo Range, Nevada, by tracing float to its source. In this instance, while slowly ascending, in the meanwhile observing and occasionally breaking rocks for observation, especially quartz; a honey-combed, yellowish stained quartz containing traces of a lead mineral was noticed. The superficial geographic feature of the region was a small valley encompassed by gradually rising hills. The natural assumption was that this rock to be traced originated at some higher level. If, at its source, a great tank of water had been emptied, the water flow would about cover the same ground as the float. Slowly walking up the grade in a zig-zag fashion, a second piece of this same characteristic quartz was discovered, and farther up more was picked up. Finally the float was traced to a steep hill, and in traversing the foot of this hill, much of the quartz was found in a trace of a water course. The source of the ore was found about half way up the hill and a distance of about a mile from where the first float was seen. The tracing took about half a day. The locator was surprised to find such a large amount of float coming from such a small vein.

Tales of lost mines such as the Breyfogle have been of interest to many. Likely, in most of these cases, if gold was found it was merely float from some hidden source.

Before me is a letter just received from a man in Dixieland, California. He states: ''Sample No. 6 consists of models of gold nuggets found in this district. They were found on a dead man near here twenty years ago. I saw the nuggets.''

The assumption is, I presume from further statements, that the unfortunate man did not possess the gold before he went on his fatal prospecting trip in the Mud Hills.

About two years ago a woman visitor at our office exhibited a piece of native gold worth several dollars. She stated that her home was in the southern part of the State, but while vacationing near Downieville, Sierra County, she had found the metal on a mountain side; there being no visible signs of mining work in the vicinity.

When gold is found in the hills as float, the discovery spot should be immediately marked, and then if a superficial tracing expedition does not reveal more, a systematic examination of the ground by panning should next be undertaken.

In making a preliminary examination of a section by panning, such as the hills on the side of a canyon, some prospectors take samples from little gullies, or small water courses, or pick out portions showing yellow or red stains that are caused by oxides of iron resulting from the oxidization of some iron-bearing mineral. Sometimes it will be found that a small hillside gully or a trace of a water course will yield a color or more in a pan. If it is thought justifiable, systematic prospecting should start where the best indications of gold were found.

When a mountain side is a thousand feet or so from top to bottom, a line of samples at its base may not be sufficient. A line parallel to the base or crest could be taken every two hundred feet or so.

Frequently a quartz vein will outcrop only in spots, but the general course of the vein can be traced. In this case it is advisable to start about fifteen or twenty feet below the apparent course of the vein and sample the ground at intervals of twenty feet or so. Even when a vein outcrops, such sampling is usually advisable.

Gold-bearing quartz veins do not necessarily out-crop at the surface. Some veins are heavily penetrated with sulphides such as pyrite, and these sulphides oxidize leaving the quartz in a state that can easily be crumbled, the result being that sometimes instead of an outcrop there is a depression and no visible sign of quartz. The oxidization of iron-bearing minerals will often stain the surrounding overburden a reddish or yellowish color. Some prospectors make a special effort to pan such discolored zones.

A regulation gold pan is most suitable for panning loose earthy material. When quartz is pulverized in a mortar a handful of the material can be conveniently panned in a small frying pan free from grease. Pans should be kept clean by scouring them with sand, pumice or similar material.

Most of the large gold-bearing quartz outcrops in the United States have been discovered, but undoubtedly there exists many valuable deposits of gold and other minerals that are hidden from surface view; some of these will be discovered by methodical searching and some by accident.

USE OF THE PAN IN PROSPECTING

With a little effort anyone can soon become skilled in the practical use of a miner's pan. For the novice it would be advisable to begin with a small frying pan that contains no grease; in fact, such a pan will answer for all prospecting purposes in the absence of a regulation gold pan. For the first attempts at this method of concentrating, a couple of pounds of sandy gravel and a few flakes of gold or some other heavy mineral, such as a small amount of the sulphide of lead, called galena, or cinnabar, the red sulphide of mercury, should be mixed with the gravel. A single sample can be used over and over again.

Fill the pan about three-fourths full of the material to be tested; hold it in a horizontal position and slowly submerge it in a large basin or tub of water. With the fingers thoroughly mix the water and sample, picking out any large pebbles; this may be done while the pan is either under or out of the water. With the horizontal position as a start, shake the water-filled pan rapidly with a rotating movement, tipping it in the meanwhile slowly and slightly from the horizontal. After thus shaking the pan a few seconds, hold it in the slightly tipped position and give it several rapid, short, jerky shakes from side to side in order that the heaviest minerals may sink towards the bottom. Keeping the slightly tipped position, again slowly sink the pan in the water, rotate and tip it a little more to float off the top material which would be the coarser pebbles. The object is to retain only the heavy mineral grains that should now be in the lowest part of the pan. This operation of submerging, rotating, shaking and tipping the pan is repeated several times; each time a little more of the sample is floated off, until a stage is reached where only about a tablespoonful of the sample is left and the pan is in a greatly inclined position with the heaviest of the remaining grains in the very bottom. For the final investigation have just enough water in the pan to cover the remaining concentrates, hold it about focal distance from the eyes—elbows to the sides and the pan tipped towards you. Now, shake the greatly tipped pan with very short, quick strokes, meanwhile slowly raising one side in an effort to have the heaviest part of the concentrates form a 'tail' in the ridge of the greatly inclined pan.

Examine the 'tail' very carefully for any traces of gold or any other heavy material. With a magnetized knife blade stir the 'tail' concentrates while they are covered with a little water. Magnetite grains and fragments of iron will be picked up; examine the concentrates again after using the magnetized knife blade. If gold is thought to be present, watch it carefully in the meanwhile slowly turning and tipping the pan. Gold retains its color in any position while pyrite or other mineral grains that may resemble gold in one light reflection may change color when the angle of reflection is altered.

For a beginner, known minerals should first be used in panning. Gold-bearing rock of a milling grade can generally be obtained in any gold mining district; also, pan the common sulphide of iron called pyrite. Next to gold, the sulphide of lead called galena is probably the most important mineral to pan and learn to identify. Galena is often associated with silver and gold. There are gold ores that will not show a color (one visible grain of gold) in a panning test, but such ores often contain a small amount of galena or the lead carbonate called cerussite which is usually almost white in color. In these cases the gold is so finely divided and intimately mixed with the lead minerals and pyrite that it can not be seen even with a powerful hand lens. Such an ore was found in the Surcease Mine in Butte County and at other properties in this State. Whenever lead minerals are found, the ore should be assayed for gold and silver. In the case of tellurides, which are very scarce in California, there is practically always enough free gold present to give colors in panning, but if not, the tellurides will concentrate and will be investigated by a careful observer.

We usually associate the operation of panning with gold; but silver, lead, tungsten, quicksilver, and platinum metals can also be found by this simple method of concentration.

SAMPLING OF VEIN DEPOSITS

A special article entitled 'Notes on Sampling, as Applied to Gold Quartz Deposits' by Homer D. Erwin, Mining Geologist, was published in California Journal of Mines and Geology, January, 1934. Quarterly Chapter of State Mineralogist's Report XXX, to which the reader is referred.

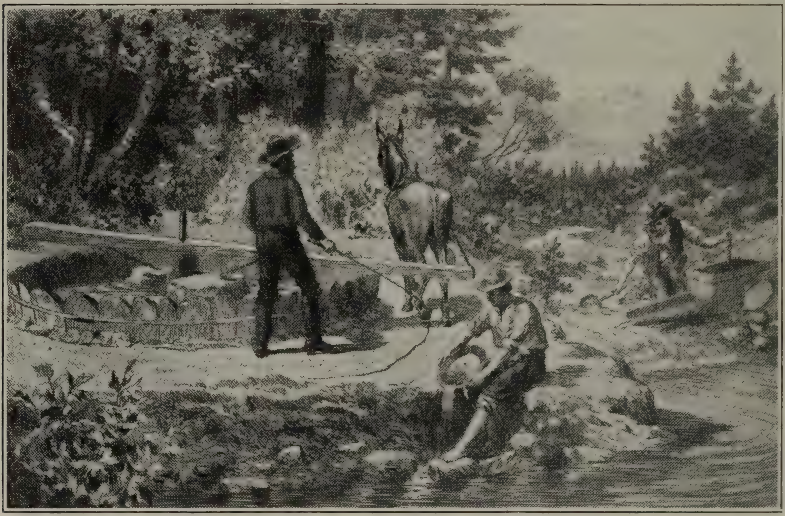
MILLING OF GOLD ORES

In addition to the many textbooks and other works on ore dressing, stamp milling, cyanidation, and flotation, a number of bulletins have been issued recently by Federal and State bureaus discussing in a general way the treatment of gold-bearing ores. Among them are:

'Gold Mining and Milling in the United States and Canada'—current practices and costs, U. S. Bureau of Mines, Bulletin No. 363; 'The Recovery of Gold from its Ores.' Pamphlet No. 37, Idaho Bureau of Mines and Geology; 'Treating Gold Ores,' Bulletin No. 133, Arizona Bureau of Mines, and various papers prepared by the technical staff of companies supplying equipment and reagents.

All have been drawn upon freely by the writer in an endeavor to aid and somewhat enlighten the small operator and prospector on the problem of recovering gold from vein deposits.

Numerous inquiries coming to the Division of Mines, such as: ''Please tell me how to build a small cyanide plant. I would like the formula in nontechnical language.'' ''Kindly tell me how to separate gold from quartz rock without a smelter.'' ''Please send booklet on new process of mills and ore treating with chemicals.'' ''We would like to get information on oil flotation for gold * * * what other metals in a free state will it work on; what oils are used and how is the metal recovered from the oil?'' ''I understand there is a certain kind of oil used in the flotation process. Could you tell me what kind and price. I would like a small outfit.'' ''If concentrating tables are used what per cent of the gold in the sulphide form can be saved by using the flotation system?'' ''Please send instructions for making a small cyanide plant,'' and other similar ones, illustrate the need for a brief outline of the basic factors to be taken into consideration in treating gold ores.



Primitive Gold Recovery Methods—Pan, Rocker, Arrastre. Cut by courtesy of The Argonaut.

At the outset it is well to remember two axioms: First, do not consider building any mill, until enough ore has been developed or blocked out to keep the mill running long enough to repay its cost and provide a profit. Second, do not build a mill or treatment plant until the ore has been thoroughly tested at some metallurgical laboratory to determine the proper milling process to give the best extraction at the least cost. The latter is imperative in the case of a company about to expend any considerable sum in the construction of a mill and it is equally desirable even in the case of a small plant for no mill operation can be successful unless the plant is suitable to the ore to be treated. For small operations a preliminary investigation of a 100-pound sample may be all that is necessary to determine what process is most applicable, and its cost will be money well expended as it may save the loss of the whole investment.

Types of Ores

Gold ores may be divided into several groups with regard to gold recovery methods: 1. Shipping ores. High-grade ores suitable for shipment to smelters without preliminary treatment, other than to hand sort in some cases, to remove very lean rock. A discovery of shipping-grade ore brings the quickest returns to the operator. 2. Free-milling ores. Ores in which the gold occurs as small particles of native gold in a quartz or other gangue rock and from which most of it can be recovered by amalgamation after suitable grinding to release the particles. 3. Non-amalgamating ores. Ores in which part of the gold may be free, but in intimate physical association with pyrite, galena, arsenopyrite, antimony, tellurium, chalcopyrite, etc., or due to the presence of graphite or talcy material, other methods than amalgamation must be used. 4. Complex ores. Similar to the above but carrying secondary amounts of base metals, lead, zinc, copper, etc., making recovery of the latter also profitable.

In deciding on a milling process the ore should be investigated with regard to its grade, uniformity, coarseness of the gold and its mineral associations. The latter is probably the most important factor in selecting the milling process.

Low-grade ores can usually be successfully treated only on a large tonnage basis and in a plant that will give a high recovery. Better grade ores can be milled profitably on a much smaller scale, requiring less expenditure for a plant, and if they are sufficiently rich will yield a profit even with a poor extraction of values. The last accounts for many early-day tailing piles that have since been reworked.

Uniformity of grade of the ore going to the mill is important as abrupt changes in value may throw the mill operations out of gear and cause high tailing losses. This is particularly true of cyanide plants, but it is not so disturbing where amalgamation is used. Large mines have the advantage of being able to more or less control the grade of mill rock.

If coarse free gold is present it should be recovered in the coarse state and it is good practice to use amalgamation. Such gold can also be recovered on shaking-type concentrating tables or on stationary tables using riffles and blankets, carpet, corduroy or similar material. Coarse gold is not readily dissolved by cyanide solution and the time of treatment required by this process alone would be too long. Amalgamation is frequently followed by regrinding and cyanidation.

Fine grinding is required to unlock the values when the gold occurs as very small particles and this adds to the milling cost. Such ores are usually treated by cyanidation or flotation. As cyanide has a dissolving action, in some cases it will make a satisfactory extraction of the fine gold after relatively coarse grinding. If the gold is intimately associated with sulphides a large part of the values can often be recovered as a flotation concentrate, followed by finer grinding and cyanidation of the remaining pulp.

The minerals associated with the gold in ore are important in deciding on the treatment method. Pyritic ores usually will not give a good extraction by amalgamation alone and these are usually treated further by mechanical concentration, flotation or cyanidation, or amalgamation may be dispensed with entirely. Other sulphides of base metals have also a tendency to foul quicksilver especially those of antimony and arsenic. Some arsenic and antimony compounds also cause high cyanide consumption and tend to deoxidize and foul the solutions or they may form compounds which will precipitate the gold already in solution.

Telluride ores will not amalgamate. They can be cyanided after fine grinding and roasting or may be treated raw by a special bromo-cyanide process.

A group of substances called 'cyanicides,' including certain metallic oxides, carbonates, hydrates, sulphates, etc., react with cyanide and destroy its effectiveness. Soluble copper salts are among the most troublesome cyanicides.

Carbonaceous matter in an ore will sometimes sicken the mercury on amalgamation plates and it causes increased consumption of cyanide and precipitation of gold from solution.

Many greasy, colloidal, or talcose substances are present in the ore fed to gold mills and in noticeable quantity may have serious effects. Oil and grease from the mine or crushing machinery are very deleterious to amalgamation, causing sickening. Talcose and clayey ores may have much the same effect and talc or other hydrous silicate minerals of magnesium and aluminum may cause a slimy froth to coat part of the gold and render it unrecoverable on the plates. Colloidal, greasy, or clayey minerals like kaolin give trouble in flotation by diluting the concentrates, since usually they are not depressed or removed by preliminary treatment without high tailings losses or excessive cost, although starch material is now sometimes used with success to depress talc and kaolin. Colloidal and clayey materials are a common source of trouble in filtration, and they increase the difficulties of gravity concentration or cyanidation by fine sliming.[1] Sometimes a talcy ore can be run into settling tanks before passing it over the amalgamating plate. After a soaking, if the talc once sinks, it does not again have much of a tendency to float and recovery by amalgamation will usually be improved.

Strong alkalies or acids either in the ore or mill water will often act on the copper of the plates or on the mercury and interfere with good mill operation.

Water being of prime importance in all gold milling operations, the location of the mill should be made with due regard to a source of water. From one to six tons of water per ton of ore treated is about the usual requirement.

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[1] Jackson, Chas. F., and Knaebel, John B., Gold Mining & Milling in the U. S. and Canada. U. S. Bureau of Mines, Bulletin 363.

Likewise the disposal of the tailings or mill waste must be considered. If possible they are generally run by gravity through a pipe or launder to a suitable basin. Sometimes they are discharged into a stream but the mill owner runs the risk of having his operations stopped on account of stream pollution. Cyanide solution is a deadly poison, and special precautions must be used in disposing of cyanide tailings to prevent human beings and animals from endangering their lives. When water is scarce or the tailings are believed rich enough to save for further treatment they are often impounded behind a dam and the water pumped back for reuse.

MILLING PROCESSES

The common methods for extracting gold from its ore derived from lode deposits are:

1. Hand sorting.
2. Amalgamation.
3. Gravity concentration.
4. Flotation concentration.
5. Cyanidation.
6. Smelting.

There are today few if any gold ores that cannot be successfully treated by one or a combination of two or more of the above processes, properly applied.

HAND SORTING

This step, as its name implies, consists of picking out lean or barren rock from the ore as mined or after a primary crushing and washing. It is sometimes done underground thus reducing the amount of rock to be hoisted. At small high-grade mines it is often the only step taken before shipping to a smelter, but it is also practiced at many large properties, notably the Alaska Juneau.[1]

AMALGAMATION

This process is one of the oldest known methods of gold recovery. It is based on the fact that when clean bright gold comes in contact with mercury (quicksilver) they unite forming an alloy or paste called amalgam. The gold loses its color and becomes more brittle. Amalgam varies in hardness and color according to the time of contact and size of the gold particle. Amalgam is heavier than mercury and will sink in an excess of the latter. Mercury will also amalgamate with silver, copper and some other metals and for this reason galvanized iron (zinc) or tin pails should never be used in handling amalgam from clean-ups, as the mercury will attack them. Hard amalgam will not catch gold and it should be kept in a pasty condition by addition of more quicksilver.

In this process the ore is crushed in water to a fineness which will free the gold from its gangue, usually from 14 to about 40 mesh. This may be done with stamps, roller mills, ball mills or other type of crushing and grinding machine or in an arrastre. The crushed ore in the form of a thin pulp, about 10% to 25% solids, is next passed over the amalgamating plates which are set on a slight slope, depending on the fineness of the gold. The slope should be sufficient to keep the material in free motion but if too great some fine gold will be washed over the plate without coming in contact with the mercury. The plates are usually 4′ to 5′ wide and 6′ long. They are of copper or silver-plated copper, into the surface of which mercury has been worked to form a clean, bright, amalgamating surface. They must be kept in good condition for satisfactory results.

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[1] Jackson, Chas. F., and Knaebel, John B. *op cit.*

A silver-plated copper plate is more satisfactory for amalgamating than a raw copper one, as mercury can be readily worked into the silver coating. Mercury can be worked into a plain copper plate however, by following the method outlined for applying it to a copper-bottom gold pan (see page 230).

When first starting to use a plate it may turn brownish in color (verdigris of the millman) and this will often persist until a coating of amalgam has been built up. When verdigris forms, hang up the mill and rub the plate with a soft cloth and hot water, until clean and bright. Gold will not take hold of the discolored portion and it may be necessary to dress the plate every two or three hours until it has 'built up' a coating of gold-amalgam. Use a soft cloth instead of a rubber scraper until the plate has been brought into good condition. It may take several weeks before it is even in fair condition. Do not use too much quicksilver. If too much is used, little tears of the metal will form and drip off.

At regular intervals the gold-mercury amalgam that has accumulated is removed by scraping and the plates carefully redressed with new mercury. The amalgam is squeezed in a chamois skin to remove any excess quicksilver. The remaining hard amalgam is next retorted, the quicksilver vapor condensed and recovered for further use and the gold melted down with proper fluxes and cast into a bar or button for shipment to the Mint.

It is only on exceptionally clean quartz ores carrying coarse free gold that a good extraction can be made solely by amalgamation. Most ores contain some very fine or rusty gold and sulphides which escape amalgamation and 70% to 75% recovery is about the best that can be expected.

However, this process requires only simple equipment, it yields gold bullion readily marketed and it requires less time for a person to become proficient in its use than either cyanidation or flotation, all of which are distinct advantages to the small operator.

The Arrastre

This primitive type of mill for working gold and silver ores, sometimes also called a drag mill, was introduced into California by early-day Mexican miners. In a short time arrastres were numbered by thousands. They were built and operated in practically every mining district, remains of old arrastres being found from the Mexican border to Siskiyou County on the north. Storms [1] mentions one small district in southern California, in what is now Riverside County in which could be seen the ruins of no less than 125 arrastre basins built and operated by Mexicans who packed the ore from mines in the surrounding country on burros to Arrastre Cañon, in the bed of which water was available.

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[1] Storms, W. H., How to build an Arrastre, Engineering & Mining Journal, May 27, 1911.

The arrastre is essentially a fine-grinding and amalgamating machine suitable for ores from $\frac{3}{4}$ inch to 100 mesh. Although the arrastre has been largely superseded by stamp mills, ball mills, etc., it still remains one of the cheapest and best gold-saving devices where small rich veins are to be worked in more or less inaccessible and remote regions. Its chief advantages are that it can be built by a man of limited mechanical skill from materials to be had almost anywhere.

The present revival of gold mining activities, lode as well as placer, on a small scale by persons with very limited capital has brought a number of inquiries for plans for building an arrastre, and directions for operating one.

In size these mills range from small, rather-crude affairs 3 or 4 feet in diameter with a daily capacity of a few hundred pounds of ore to well-built mills 8 to 12 or more feet in diameter with a crushing capacity of 3 to 6 tons daily. Any power may be used: Horses, mules, water wheels, gas and steam engines or electric power, but in the latter cases the speed must be reduced by suitable pulleys and belts or gearing. Where water is available, overshot waterwheels have generally been utilized as the simplest and cheapest power.

An excellent example of a first-class double arrastre each basin 12′ in diameter built at the Commodore Mine, Siskiyou County, at a cost of $700 and crushing 5 tons of ore per 24 hours is illustrated and described in State Mineralogist Report XIII, 1896. This particular double arrastre was driven by a wooden hurdy wheel 18 feet in diameter set between them, using 30 miners inches of water supplied through a 7″ pipe with a 2″ nozzle under 100′ head. One man on a shift was required to operate it. For every $20 gold in the ore, 2 ounces of quicksilver was added gradually to the charge, which consisted of $1\frac{1}{4}$ tons of ore broken to the size of a walnut. The speed of 12 revolutions per minute was reduced during the final 2 hours of grinding, the total time for reducing a charge being approximately 12 hours.

A much simpler, single arrastre, having only 2 drags or mullers instead of the usual four, designed for mule power is shown in the sketch herewith.[1] The timber (a) must be long enough to clear the mule walk and it must be rigidly supported.

A cut of a 10′ belt-driven arrastre used at the Georgia Mine, Inyo County, is also reproduced from State Mineralogist Report XIII, 1896.

The sides of the arrastre may be made of staves set upright and bound with hoops, or of circular segments of 2″ plank laid flat and solidly nailed together. In the center a large stone or post is firmly set as a step for the lower pivot. The floor is smoothed off and covered with a layer 3″ to 4″ thick of puddled and well-tamped clay so as to make the whole basin tight. Upon this a layer of sand 6″ thick is spread. The floor of the basin is then built of blocks of some hard, tough rock fitted as closely as possible but left with rough edges. It is made slightly higher at the center and outer edge (except where the discharge gate is placed) than in the middle. These blocks should be firmly set. If preferred the bottom layer and sides may be of brick

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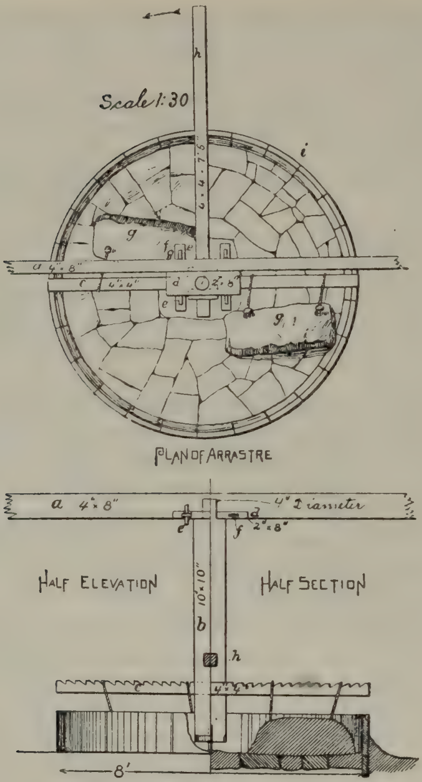
[1] Mining & Scientific Press, Vol. 52, Number 15, Apr. 10, 1886, p. 237.


Scale 1:30
h
i
g
f
e
a 4"×8"
c 4"×4"
d
2"×8"
g
PLAN OF ARRASTRE
a 4"×8"
4" Diameter
e
f
d
2"×8"
HALF ELEVATION
HALF SECTION
10"×10"
b
h
c
4"×4"
8'

DETAILS OF CONSTRUCTION OF ARRASTRE.

Small Arrastre With 2 Drags.

A 10-ft. Belt-driven Arrastre.

work or it can all be made of concrete, with clay, sand and rock pavement. Massive diabase, diorite, quartzite or granite make good arrastre floors and drags. The latter is better if it contains a large proportion of quartz. As the drags may weigh from 800 to 1000 lbs. it is advisable to rig up a derrick or winch to handle them during construction and when cleaning up. Each drag is drilled with one or more holes about 5″ deep into which eye bolts are placed and tightly wedged, to which chains are attached. Lead should not be used in setting the eye bolts as it might work loose and fall into the arrastre and foul the quicksilver. The drags should be so placed on the arms that every part of the floor is swept by them during each revolution, and so that the pulp swept aside by one drag will be in the path of the next following one, thus increasing capacity.

Capacity is also increased by having the feed broken quite small, 1″ or less. The drags should also be suspended by their chains so that their forward edge will be raised about 1″ above the floor, thus permitting the coarse material to pass beneath them instead of being pushed aside. The use of grease or oil on the bearings must be avoided as it would contaminate the mercury.

Sluice ways or gates are provided in each basin. These should be about 6″ wide, the gate sliding vertically. The gateway opening should extend about 4″ below the floor and two or three 1″ filler strips placed below the gate for it to rest on. This will permit the height of the discharge to be kept nearly uniform as the floor becomes worn down. The bottom of the discharge when open should be about 1″ above the floor level. The mode of operation is given by Storms[1] as follows:

Amalgamation is accomplished in the basin, though some operators place copper plates, riffles and blankets in the sluices leading from the basin, to catch any amalgam that may escape at cleanup time. The usual method of operating is to charge the ore a little at a time, adding enough water to make the pulp the consistency of thin mortar, so that the coarse particles will be constantly lifted and brought beneath the grinding drags. Fast crushing can not be done if the pulp is too thin. After grinding from five to seven hours the pulp should be sufficiently fine to add the mercury, when grinding continues for two or three hours longer—until all the free gold present appears to have been taken up. This is determined by testing the pulp from time to time by panning a little in a hornspoon or pan. Enough mercury must be added to amalgamate all the gold in the charge. If too little is added, it will make hard amalgam which may be then ground so fine as to flour, when it will be difficult to recover. Too much mercury is better than too little, for if too much the superfluous quantity will settle in the crevices between the rocks of the basin floor and can be recovered.

When all the gold seems to have been amalgamated reduce the speed of the drags to not over 150 feet per minute on the outer rim. The peripheral speed of the outer drags at no time should exceed 360 feet per minute, when the mercury is present in the charge, though before adding it there is no objection to a higher speed if it is found to crush the rock more rapidly. Generally speaking, more and heavier drags is preferable to excessive speed of rotation, as high speed tends to injure the construction of the basin and in fact, of all the moving parts of the machine. After slowing down add more water. This will permit the coarse grains to settle and be crushed. All the amalgam and mercury should now settle to the bottom of the basin collecting in the crevices of the rock floor. When the pulp is free of particles of amalgam, as determined by panning, the gate may be carefully opened and the basin sluiced out quietly by addition of water and carefully raking the pulp toward the outlet. Some arrastres are provided with screens through which the finely ground particles of sand pass, as in a stamp battery, but this practice is unusual. Also some arrastres have a series of auger holes provided with wooden plugs as well as gates, for sluicing out the pulp, the upper hole being opened first, then the next lower, and so on to the bottom, but if the amalgam has settled, when the drags are stopped, lifted up and washed off, there is little probability of serious loss in fully opening the gate at once.

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[1] Storms, W. H. *op cit.*

The arrastre is usually only cleaned up throughly when the bottom is worn away; between times the crevices are picked out for a depth of an inch or two with picks, scrapers and spoons and panned out with what pulp remains on the bottom after the charges have been thinned down and run off through the gate or plug holes.

The first cost of a good arrastre should not exceed about $300. Milling costs using a double arrastre driven by water power and attended by one man on a 12-hour shift are estimated to vary from $1.25 to $2 a ton.

Other Small-Unit Reduction Mills

The stamp mill was for many years the standard type of mill used for the reduction of gold ores in California, and it will doubtless be used for many years to come. However with the advent of cyanidation and later the flotation process, requiring finer grinding, ball and tube mills have been substituted at many of the more modern plants.

It is not the intent to discuss in this paper the many different mills that have been developed which include, besides the above mentioned, Huntington Mills, Chili or Bryan Mills, Cannon Ball Mills, Hammer Mills, Griffin, Kinkead, and many others; but simply to list and briefly describe some of the smaller reduction mills now on the market suitable for the prospect or small mine. In passing, it may be interesting to note that according to Richards[1] the distribution of the machines in the gold quartz mills of California for the years 1895 and 1896 was as follows: Gravity Stamps were used in 551 plants; arrastres in 108; Huntington Mills in 43; roller quartz mills in 4; Tustin pulverizers in 3; Dodge Pulverizers in 2; and Kinkead Mills in 2; total 723.

The name and address of the manufacturer of any of the following equipment will be supplied upon request.

Amador Rocker Quartz Mill. This mill was invented in the 80s and was extensively used in the early gold mining camps. It is stated that its first cost was one-third the price of stamps, cost for freight and haul nominal compared with other equipment and erection cost was calculated to be but five per cent of that of the stamps.

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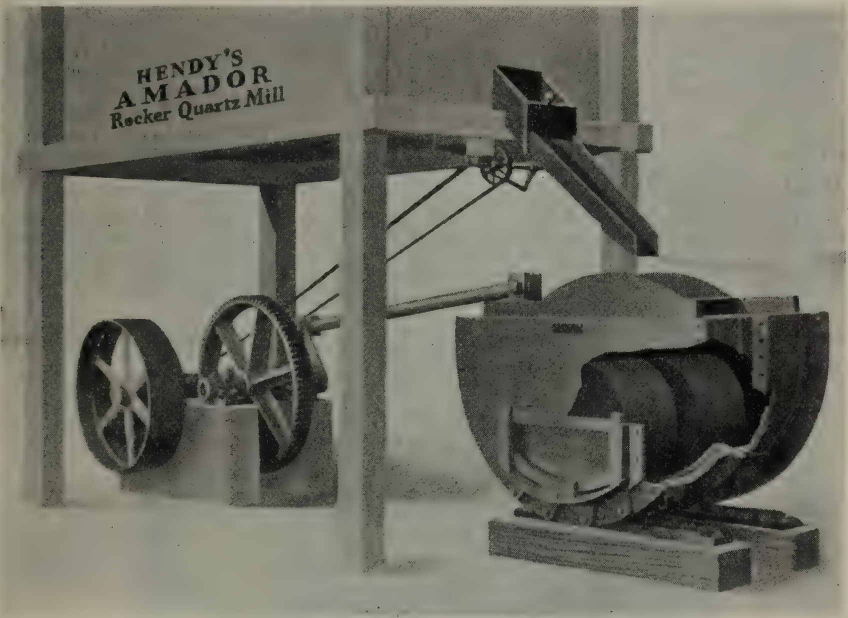
[1] Richards, Robert H., Ore Dressing, McGraw Hill Book Co., New York, 1905.

"The Amador rocker quartz mill requires 5 h.p. It yields an average of 12 to 15 tons in 24 hours of ore crushed to 1 inch, grinding it all to pass a 30-mesh screen. With a finer feed the capacity will be correspondingly increased using the same horsepower. Due to the rocking motion of the mill the roll takes a short drop not unlike a stamp—then slides a short distance as in an arrastre and finishes the stroke by a rolling action as in a Chili mill. Therefore, the mill reduces the ore to the desired fineness first by impact then by attrition and a rolling action which frees the gold and scours it for amalgamation within the mill and the greater part of the gold is recovered in the amalgam traps at each end of the mill.

"Weight of mill, including liners, spur gear and pinion, and feeder, but not the drive pulley is about 7000 lbs. For places where roads do not exist the mill is built sectional.



Amador Rocker Quartz Mill.

"Owing to the simplicity of its construction, accessibility for cleanup and overhauling, economy in running and cost of repairs, the quantity of rock it granulates per 24 hour day and its prodution of a pulp suitable for amalgamation or concentration, its performance equals any stamp or ball mill."

In the latest mills put out driving mechanism and rocker have been mounted on a single solid metal base.

Air Stamp Mill. This is a single stamp, operated by compressed air which is said to make from 15 to 20 tons of pulp per 24 hours, according to mesh. 15 tons to 40 mesh; 20 tons to 30 mesh, and so on. Said to take less air to operate than to run a jackhammer.

Crown Muller Mill. Very efficient, low operating cost; requires no special foundations and is recommended especially for grinding porphyry and siliceous ores where amalgamation and agitation is essential for recovery of values. Ore samples will be run at the company's plant without obligation.

El Gambusino Quartz Mill. A small high-speed beater-type mill built for selective mining. The revolving beater resembles somewhat the impeller in a centrifugal pump. The ore is broken by being thrown against the sides of the housing and enough air is drawn in to carry off the fine material through the discharge opening at the top. By varying the discharge area the fineness of the material that will be drawn out is regulated. All wearing parts can be replaced at small cost.

Capacity, 3 tons of ore in 8 hours to 40 mesh or finer. Weight, 425 lbs. Horsepower required, 8 to 10.

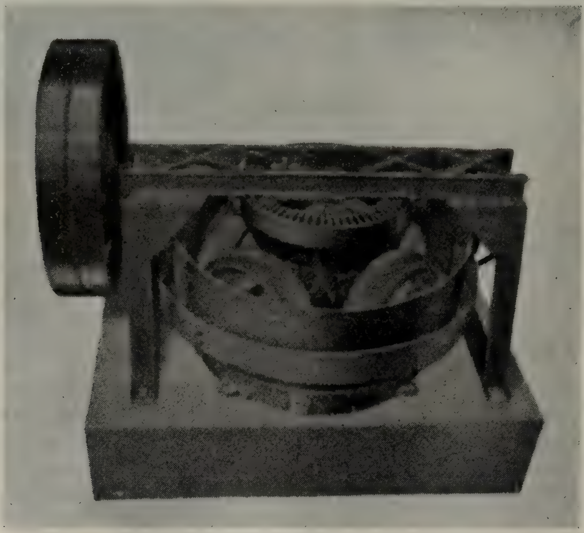
The Ellis Ball Chili Mill. The manufacturers state:

"The Ellis mill will grind anything that can be ground or pulverized, wet or dry, to a definite mesh in one operation, using only ¼ to 1/10 the power others use. The Ellis ball mill is simple, rugged and strong; no grease, no bearings, and with even the minimum of attention nothing to get out of order. The liner and balls, parts that are subjected to the greatest wear and tear are made of a special alloy calculated to give the most tonnage. The Ellis mill is the only mill on the market today in which you can amalgamate inside of the mill. On account of the constant sideward motion of the balls, this mill will scour gold far better than any other and will remove tarnish or oxidization from the gold generally called rusty gold. In some cases the screens may be removed and a solid sheet substituted. The mill will then slime by overflow, and by using mercury inside of mill, you will have the best classifier and amalgamating pan to any mesh.

These mills are made in various sizes from the Giant mill, with rated capacity of 10 to 20 tons per hour to 40 mesh, to the Ellis Midget mill, which will grind wet from 50 to 100 pounds per hour of ordinary quartz to 40 mesh, feed being ¼-inch. The Midget is 19" in diameter. It has 7 balls 4" in diameter and is operated at 100 to 150 revolutions per minute. It can be operated by hand but a ½-h.p. motor is preferable."

The company also manufactures a rock breaker, ore feeder, electric amalgamator and other mill equipment.

Garcia Mill. Important features of the Garcia mill are:



Garcia Mill.

"Grinding Area—The stationary trough or raceway is continuously filled with ore and contains a volume of two cubic feet. The 4 rolling mullers or grinding wheels, the only moving parts of the mill, have a combined weight of two and one-half to three tons, rotate at an average speed of 27 revolutions and traverse a grinding area of 1000 square feet per minute.

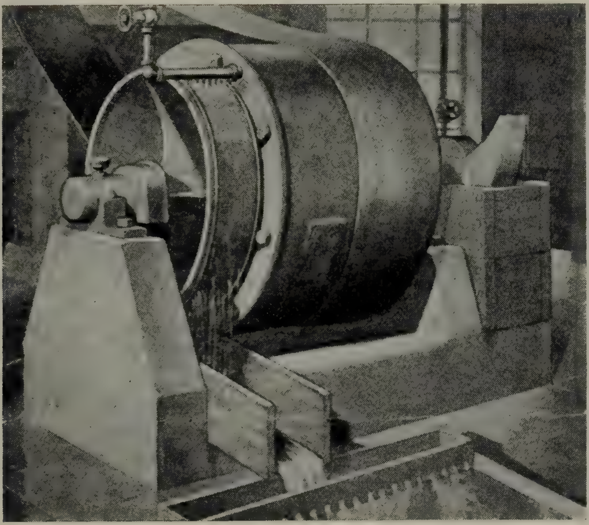
"Grinding and Scouring Action—The proportion of the curvature of the muller face to the curvature of the trough or raceway and the proportion of the circumference of the grinding mullers to the mean diameter of the raceway has been developed to produce a definite bi-lateral grinding and cross-scouring effect required for amalgamation and other methods of recovery. Unnecessary grinding and the accumulation of excessive fines is prevented by automatic discharge.

"Knee Action—There is a definite free knee action of the mullers resulting from the use of the toggle joints by which the mullers are attached to the driving columnar shaft. This knee action permits individual performance of the mullers while all rotate in unison, leaving each muller to adjust itself to the ore immediately beneath it without impairing the efficiency of the others.

"Minimum Power—The power is directly applied to the rolling mullers. Due to the knee-action method of attaching the mullers to the driving column, the supporting thrust bearing carries only the column weight eliminating the load and excessive friction. Ten horsepower is ample to operate the mill.

"No Screens, Self-impelled Classification—Screens, with their attendant expense and complications are not necessary because of the accurate control and regulation of the finished product by natural law of water tension and gravity classification.

"Iron Consumption and Replacement of Parts—The muller wheels constantly ride upon a cushion of ore permitting no contact of iron with iron; consequently, minimizing iron consumption. The only wearing parts are the four muller wheel rims and the eight trough liners. The trough liners, being bolted to the trough, can be removed with ease and replaced without dismantling the mill. The muller wheels can be reversed to equalize wear or the rims replaced if necessary."



Little Giant Rib-cone Mill.

Little Giant Rib-Cone Mill. The Little Giant rib-cone mill answers the demand for a small but practical mill.

"Made entirely of steel, complete with the exclusive built-in screen classifier head, the Little Giant is in a class by itself. Note this vital fact—you do not have to buy another classifier for the Little Giant—it's complete!

"The Little Giant regrinds its own oversize within itself, discharging a sized and finished product direct to amalgamating plates, concentrating tables, etc. Little Giant grinds so fast and so well that sliming is prevented, insuring the largest saving of values. Little Giants grind to any desired mesh within the limits of screening by simply changing the screen.

"Little Giants are simple, having no moving parts except the outer shell and the steel grinding balls. They use the least power, water and space. Can be set on wood or concrete foundations. Little Giants are strongly made of the very best material and carry a full guarantee.

"Standard Little Giant mill complete with rib-cone screen classifier head. Shell, both heads, and classifier made of cast chrome steel, with integral ribs. Mill supported on a 11½" diameter bearing at feed end and a self-aligning, ball-seating bearing at discharge end. Furnished complete with a feed scoop of 13" radius. One screen on non-corrosive monel metal furnished. A hand-hole can be furnished in the shell, when required for clean-out purposes.

"Five-ton capacity: 2½ h.p. net to run. Heaviest piece of standard model, 595 lbs. Total weight, 1150 lbs. Ball charge, weight, 500 lbs.

"Nominal capacity on ordinary quartz, ⅜" ring feed, approximately as follows:

"Grinding to 20 mesh—7 tons per 24 hours.

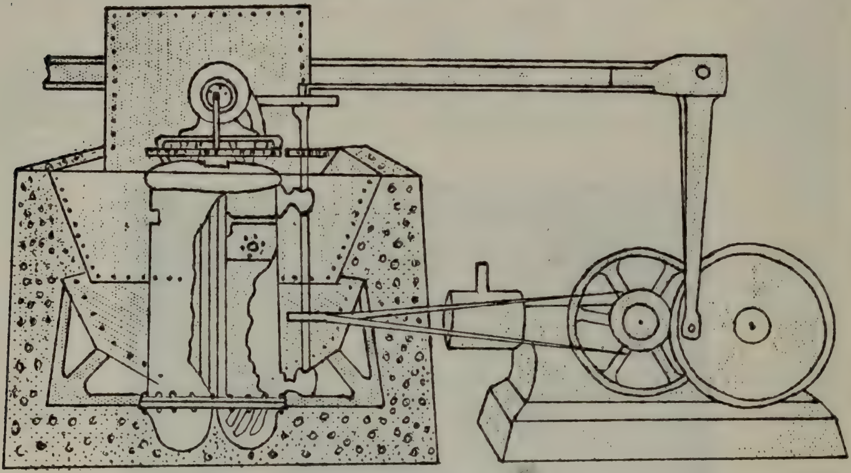
"Grinding to 30 mesh—5–6 tons per 24 hours.

"Grinding to 40 mesh—4–5 tons per 24 hours.

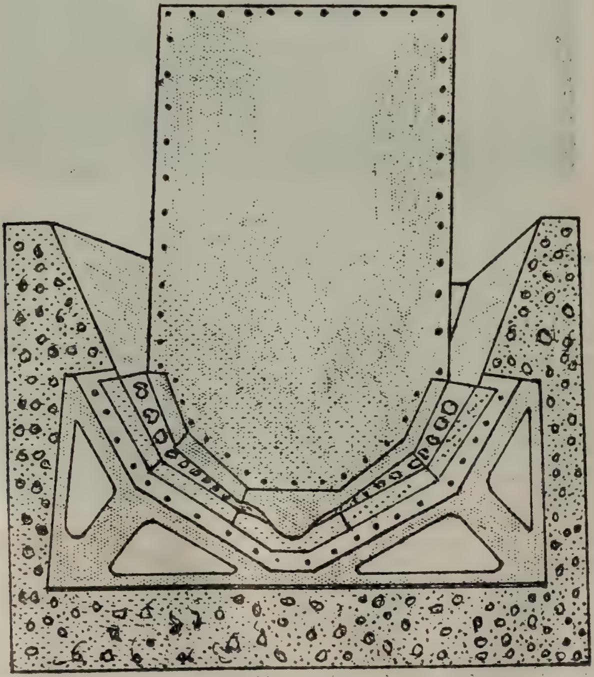
"Standard drive is by 8" belt around pulley on mill shell, 31½" diameter. Speed, 36 to 37 r.p.m. Monetary starting load, 4 h.p. net.

"Sectionalized Little Giant mill, for mule-back transportation, heaviest piece 325 lbs., total weight 1300 lbs. All other details and ball charge same as standard model."

Nenzel Quartz Mill. At all times there has been a large demand for a mill to fit the prospect, a simple mill that anyone can operate, that



Nenzel Quartz Mill.



Nenzel Quartz Mill—section through muller.

will convert the ore into money, and that will put the prospect on a self-sustaining basis at the lowest possible cost of installation and maintenance.

"The Nenzel mill combines these essential points, including the economy of water, which is an essential item in most mining areas. In the Nenzel mill the water is constantly reused, the mill operates in 18 inches of water.

"The ore is automatically fed into the mill on both sides. The ore should be broken down to two inches for best results. The ore moves forward as the crushing and grinding takes place. This is accomplished by a biased corrugation in the liners of the mortar and muller. This feature adds also to the capacity of grinding. Any rock of whatever hardness or softness will readily pulverize to any mesh desired. The fineness is regulated largely by the amount of water added. A screen, 6"x6", of any desired mesh is used at the point of discharge into the amalgamator. In the amalgamator the pulp is agitated until the gold has been brought into contact with the quicksilver. This agitation takes place under 22 inches of water. Should there be any floating gold it would also be forced down to the bottom of the amalgamator. The centrifugal pump at the top of the amalgamator continuously drawns the pulp and water from a point a few inches above the amalgamation. The water and pulp are discharged back into the head of the amalgamator, onto two revolving screens. From these screens the sands are discharged, and the water returned to the mill and reused.

"The removal of the amalgam when desired is accomplished by first cutting off the automatic ore feed. The mill should be then allowed to run for ten minutes until material in the mill has cleared. Second, let the pump run until the water has been taken out of the mill and stored, to be used again. Third, remove the bottom of amalgamator and take out the accumulated amalgam. The entire process of the Nenzil mill is about as simple as a mill can be built. It eliminates all the complicated mechanism usually found in mills. There are no bearings, gears, tubes, rods, balls, etc., to get out of order.

'The muller is oscillated by an eccentric connected with the engine. The rolling moting from its base in the pit of the mortar gives it a tremendous crushing and grinding power. The muller, when filled with rock or gravel, in a 6' mill weighs eight tons, making it truly a double jawed rock eater. The muller is 3' wide, by 5' high.

"The liners are in blocks 2' long by 2" thick of white iron. The entire mill is shipped in parts, none of which weighs more than 300 lbs. and can be packed over the most difficult trails.

"The mill can be assembled and set up in a day. Concrete can be poured in a few hours. The mill can be put in operation within six days.

"The Nenzel quartz mill is not confined to prospects. Any tonnage desired may be had. The mill is built in three sizes, merely to fit the size of your mine, be it five tons or a thousand tons per day. A six-horsepower engine will operate any of the three sizes of the mill.

"No. 1 Mill: Capacity 7 tons per day; 4 feet long, shipping weight, including amalgamator, 3800 lbs.; operating weight, 12,800 lbs.

"No. 2 Mill: Capacity 15 tons per day; 6 feet long; shipping weight, including amalgamator, 5800 lbs.; operating weight, 17,800 lbs.

"No. 3 Mill: Capacity 25 tons per day; 8 feet long; shipping weight, including amalgamator, 7600 lbs.; operating weight, 23,600 lbs."

Prospector's Friend. This mill is a combination crusher, pulvarizer and amalgamator, and will handle 4-inch material without a crusher, and if desired will grind to a fineness of 80 mesh in one pass. It is built entirely of chrome steel and is unbreakable and can be taken to the remotest parts without any fear of breakage.

"The mill is built in two sizes, 5 and 10 ton capacity. Both sizes are built for muleback transportation, all parts weighing under three hundred pounds.

"The elliptic roll, which acts as a stamp and grinder, is a hollow manganese steel shell, and is filled with lead to give added weight. When the mill has to be packed on muleback, the lead is shipped in 100 pound ingots and is melted and poured into the roll at the mine. When the elliptic roll is worn out, the lead can be remelted and poured into a new shell.

"The weight of the elliptic roll of the 5-ton mill is 400 pounds and the 10-ton mill 800 pounds.

"The screening arrangement is the same as the Gibson counter-balanced mills and will never puncture or bulge. The mill is fitted with the Gibson burr punched screen.

"Working Principle

"As the mill rotates the elliptic roll strikes two severe impacts each revolution. After striking the roll slides a short distance as it takes its position for the succeeding blow. This sliding further aids the fine grinding. At each drop of the elliptic roll the pulp is splashed against the screen much the same principle as the splash of a stamp mill, only the screen of the mill is protected by a quarter inch manganese steel grizzly. This accounts for the long screen life of the mill.

"The mill can be operated clockwise or counter clockwise and after six months' service it should be rotated in the opposite direction. This gives a new wearing surface to the elliptic roll.

"If finer grinding than 80 mesh is desired the elliptic roll can be removed and the mill charged with balls and operated as a ball mill for sliming.

"Amalgamation

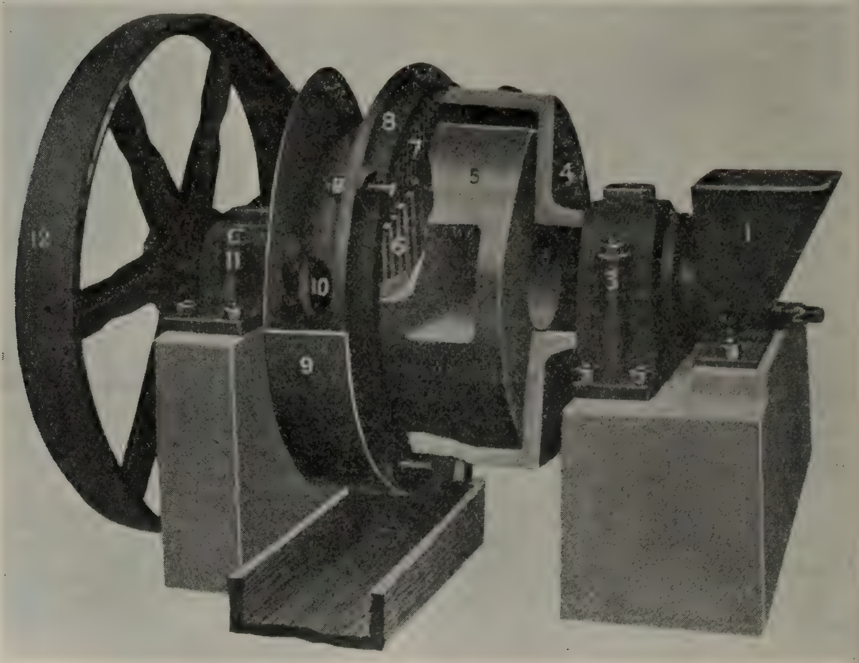
The mercury is fed into the feed hopper of the mill and amalgamation carried on inside. After the amalgam is formed it is caught on the silver plated amalgam device in front of the mill.

"This device is stationary and as the mill rotates the pulp is discharged through the two discharge ports of the mill, and the amalgam is thrown against the device with an impact that builds up a dry, hard amalgam. The amalgam device can be removed in a few minutes, the amalgam scraped off with a rubber and replaced. The whole operation takes less than fifteen minutes.

"Installation

"Installing the Prospector mill is a simple matter. If the mill has been shipped knocked down for muleback transportation it can be assembled in less than half an hour as it is only a matter of putting the parts in place and tightening up four bolts. The assembled parts are all ground to perfect fit, male and female, which removed all strain from the bolts.

"With each mill is shipped a cable block for ease in handling and after the foundation timbers are in place, the mill can be assembled, set up and running in two hours' time."



Sectional view of Prospector's Friend.

1—Feed hopper.
2—Water supply pipe.
3—Bearing.
4—Cylinder.
5—Elliptic roll.
6—Grizzly.
7—Screen.
8—Outer housing.
9—Amalgam device.
10—Left hand discharge port.
11—Bearing.
12—Pulley.

Silver Gravity Mill. A new gravity mill consisting of a steel tube or tunnel about 20 inches wide by about 24 inches deep, built into a mill building on an angle of about 78° (angle adjustable).

"The bottom of the tunnel or steel tube is tied into a heavy steel boot which receives the pulp from the mill and out of which the pulp is classified. An endless chain steel carrier or elevator operating over a driving sprocket about 36" in diameter built in the top of the tunnel or steel tube, said carrier being about 20 inches wide and supporting angle steel lugs spaced about every 16 inches on the surface of said elevator, keeps from a ton and a half to two tons of ore in transit between the idler at the bottom of the tunnel and the shoe just below the driving sprocket at the top of the tunnel. The shoe is so curved as to cause all of the large coarse material to fall backward into the tunnel instead of going over the top of the sprocket. Consequently a cataract of falling stones is constantly pouring down at an angle of some 78 degrees over the top of the load of material coming up. This material being enclosed in a heavy steel tunnel creates a very effective grinding process—the friction between a constant stream of material coming up and another stream pouring down on top of it. The fine materials are carried over the sprocket into a conveyor which carries it back into the boot above mentioned, from which it is classified according to its size and gravity.

"Another feature of the mill is the installation of a heavy anvil made out of laminated manganese plate built at a right angle to the conveyor and set in just about the curve of the conveyor over the idler at the bottom above mentioned. The rock having an almost vertical drop of about 32′, land on this manganese anvil and thereby accelerate the grinding process.

"The power necessary to operate the mill above described is about 15 or 20 horsepower.

"The capacity of the mill above described is about 300 tons per day.

"No preliminary crushing is necessary for the operation of this mill. Particularly suitable for cemented gravel."

Tadmor Mill. This mill operates by means of the inert weight of an 8000-pound muller moved with gyratory motion at 90 r.p.m. crushing the ore between shoe and die. Fineness of crushing is regulated by the amount of water introduced and use of different discharges. The cost of the Tadmor mill is said to be about one-half that of stamps for the same capacity, horsepower requirements about one-tenth as much and half the amount of water. This old established company also manufactures 2- and 3-stamp mills and a complete line of heavy standard equipment for gold and silver milling and hydraulicking, pumps, roasting furnaces, etc.

Tetrault Mill Units. This company manufactures a line of lightweight quartz milling and placer equipment including crushers, gyratory pulverizer, stamp mill, oscillating copper plates, concentrator and special placer mining machine.

Wooley Hydraulic Rotary Stamp Mill:[1] The Wooley mill differs from the ordinary stamp mill in that it is operated hydraulically and grinds the ore with a twisting motion rather than a simple vertical drop. The device is new, but a two-stamp unit is operating in Oregon with a water pressure of 80 pounds per square inch, and the water after being used in the driving mechanism is suitable for use in the battery as no oil or grease enters the power plant.

"The water used for furnishing power may be under gravity pressure or it may be supplied by a pump. In the latter case a pressure dome and relief valve should be installed in the pipe line to avoid pump trouble when the mill is shut down.

"The height of the lift imparted to the stamps may be varied from two to 10 inches by means of a valve, and the number of drops increased from rest to 90 per minute, while the mill is in operation; thus giving the operator absolute control for adjusting the mill in accordance with the type of ore being crushed.

"Each battery consists of two stamps, one rising and dropping while the other is grinding. The stamps do not revolve while being raised or dropped, but turn after the impact. The revolving, grinding action of the stamp must be completed before it can be raised again. This grinding action, which also can be regulated while the machine is in operation, creates a movement in the battery water which carries all pulp and values to the screen and eliminates the need of amalgamation plates or mercury in the battery.

"The discharge is from both sides of the battery through easily removed screens. Due to the special design of the battery the screens may be taken out and the battery cleaned in about six minutes, unless it is necessary to change the dies in which case the time required is somewhat greater.

"It is stated by the inventor that the grinding action of the stamps will not flake the precious metals, but will scour them of rust or tarnish so that a high percentage of the values will be caught on the amalgamation plates. It is also claimed that the action prevents sliming even in the case of badly decomposed or talc-laden ores.

"A positive feed by means of a specially designed feeder operated automatically by the action of the dies prevents overloading of the battery regardless of the setting given by the operator.

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[1] Described in The Mining Journal, Phoenix, Ariz., April 15, 1933.

> "The capacity of the mill is 12 tons per 24 hours grinding ⅜-inch feed through a 50-mesh screen, requiring 1½ water horsepower. When a pump must be used the horsepower required is slightly greater. The mill, including the self-contained power unit, weighs 950 pounds. Each stamp weighs 160 pounds; while the battery, which is the largest single piece, weighs 300 pounds. The latter may be made sectionally to facilitate transportation to remote regions."

Other mills include *Humphreys Hammer Mill*, described as having a hammer swinging on a lever with a "slide back out of position" movement; the *Sonora Pulverizer* and the *Macartney Mill.* Addresses will be supplied upon request.

GRAVITY CONCENTRATION

Gravity concentration is based on the fact that gold, auriferous pyrite, galena and other sulphides or metallic minerals are usually much heavier than the gangue minerals and due to their high specific gravity they can be collected into a high-grade product of small bulk.

Many concentrating devices utilizing water and the force of gravity have been used in gold mills, and still are largely used, but in recent years concentration by flotation has replaced gravity concentrating to a considerable extent, especially on sulphide ores. Among the devices used are shaking tables, vanners, and stationary tables or buddles. For the best work their feed should be classified or at least roughly sized. Mechanical or hydraulic classifiers are used for this purpose, producing coarse sands and fine slimes.

Jigs are used for concentrating heavy base ores such as lead, zinc and copper, as they will handle a feed up to a maximum of 3 inches. They have little application in a gold mill where fine crushing is the rule, although they are being used to some extent on gold dredges.

The pulp from the stamp battery, ball mill or other reduction machine after passing over amalgamation plates, should be classified. The sand product can then be distributed to shaking tables such as the well known Wilfley, Overstrom or other make operating on a similar principle, and the slimes sent to Deister slimers or vanners, designed for treating fine material.

Many variations are found in gravity concentration practice, depending on the characteristics of the ore and other factors. In some cases, amalgamation is omitted entirely and a gold concentrate taken from the tables. In others the sands are returned to the ball mill for regrinding before concentration and all reduced to a uniform fineness. Vanners, of which the best known is the Frue, consist of a wide endless slowly-traveling belt running over pulleys at both ends, the head end slightly higher than the tailing end. The feed is distributed evenly across the belt and tiny streams of wash water carry the worthless material down the belt and into a tailing launder. The heavy concentrates hug the belt and are carried over the head end into a concentrate box. The whole belt is given a short end, side or gyrating shaking motion to assist in the separation. Before cyanidation was generally adopted many gold mills used stationary tables for concentration. These were known as canvas plants, blanket tables or buddles. The finely crushed ore was evenly distributed in a thin film over wide tables set on a slight slope. These are covered with carpet, blanket, corduroy, coarse canvas or similar material to which the gold, sulphides and other heavy minerals cling.

Stationary tables are still used in many parts of the world. They are a good and very cheap concentrating device for small mills.

FLOTATION

The flotation process of concentration was used commercially on base metal ores for a number of years before it was applied to gold ores. The process is an outstanding metallurgical development that in recent years has become firmly established as one of the leading gold recovery methods. It recovers fine free gold, gold associated in any form with sulphides, and gold in oxidized lead and copper ores.[1] Coarse native gold (over 35 to 40 mesh) is practically the only gold that cannot be successfully recovered by this process.

Flotation is a method of wet concentration of ores in which separation of mineral from gangue is effected by causing the mineral to float at or above the surface of a body of liquid pulp while the gangue becomes or remains submerged.[2]

In this process the ore is crushed and ground to the required fineness in water. The pulp then passes to conditioning tanks or to the flotation machines where certain reagents—oils and chemicals—are added. These reagents collect on the surface of the metallic particles and when air bubbles are introduced into the pulp, the oiled particles attach themselves to the bubbles. Other frothing or foaming agents are added and this strong froth rises and collects on the surface of the pulp. It carries with it the gold and sulphides in the form of a rich concentrate. As it overflows the lip of the machine it is collected, thickened or filtered, and dried. It is then ready to ship to a smelter or the concentrate can be cyanided and reduced to bullion.

As flotation is applicable to both metallic and non-metallic minerals, there are a great many reagents used or suggested, singly and in combination, many of them patented. These are subdivided into 'conditioners,' 'promoters,' 'collectors,' 'frothers,' 'dispersion agents,' 'depressing agents' and others. Many types of flotation machines have been developed, their main difference being the manner in which the air bubbles are introduced. In mechanically agitated machines the air is drawn into the pulp by rapidly revolving impellors. In the so-called pneumatic machines the air is blown in under low pressure, generally through a porous mat on the bottom in order to distribute it.

By varying the reagents, density of pulp, amount of agitation, etc., rough concentrates with clean tailings, rich concentrates with middlings or high tailings, and other results can be obtained.

Although the subject of flotations is very involved and not as yet fully understood, the process can be made available to the small operator. Under certain conditions, as with cyanidation, it can be used with measurable success with little theoretical knowledge, but either thorough practical experience or some metallurgical advice is essential.

As a rule a flotation plant can be built for less than a cyanide plant requiring fine grinding and agitation.

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[1] Fahrenwald, A. W., The Recovery of Gold from its Ores. Pamphlet No. 37, Idaho Bureau of Mines and Geology.

[2] Taggart, Arthur F., Handbook of Ore Dressing, John Wiley & Sons, Inc., New York.

CYANIDATION

The cyanide process of gold recovery was introduced about 1887. In the intervening years it has become so well standardized that during the past 20 years there have been few changes except in the mechanical equipment used for crushing, classifying, transferring, agitating, thickening, filtering and precipitating; one of the latest of these being the Merrill-Crowe precipitation equipment, using zinc dust.

The process is based on the fact that gold (or silver) is soluble in a weak solution of potassium or sodium cyanide and that the dissolved gold is precipitated from the solution by metallic zinc.

There are two general methods of using this process, namely: leaching or percolation, and agitation. If the ore is of such a character that the gold can be dissolved during a reasonable period of contact, without it being crushed finer than about 10 mesh, leaching would be indicated. A leaching plant is cheaper to build and operate than a plant equipped for fine grinding and agitation. The two systems are sometimes combined, the sands being leached and the slimes agitated. Crushing of the ore to proper fineness is usually done in cyanide solution. For gold ores the strength of solution varies from .01% to .05%, that is from 0.2 lb. to 1.0 lb. of cyanide to 1 ton of water. Sands are leached in tanks with filter bottoms by covering the surface of the charge with the solution which percolates through and is drawn off at the bottom. These solutions are sometimes circulated by an air lift and repeatedly allowed to pass through the charge. After sufficient time the tanks are drained, barren solution is run on for washing and finally fresh water to remove as much as possible of the dissolved gold. The gold bearing solution is clarified, if necessary, and then passed through zinc boxes (boxes filled with zinc shavings). The gold is precipitated in the boxes as a black gold-zinc precipitate which is washed, dried, mixed with proper fluxes and melted down into a bar. Solutions will not percolate freely through very finely ground ore and in slime plants agitation is used. Agitating tanks are of various designs and agitation is carried on by mechanical stirrers or compressed air, or both. The agitation method usually requires less time for treatment and gives a higher recovery. When a charge is finished it is allowed to settle, the clear pregnant solution is decanted off and the residue filtered, washed with barren solution or water and discharged. Either system may be used on separate charges or as a continuous counter-current process, in which the solutions from strong to barren and wash water pass in one direction continuously as the ore pulp passes through the tank system to the filters and tailing pond in the opposite direction.

There are many refinements in the process and equipment that have not been touched upon in these notes. Cyanidation is a highly technical chemical process. In general it cannot be used to advantage except under the guidance of a trained metallurgist or a thoroughly experienced operator. Strength of solutions, their alkalinity, pulp density and assays of solutions and residues are vital. Lime is generally required and lead acetate in small amounts. Temperatures of solutions effect recovery and in cold climates they are often heated.

There are of course some ores, tailing dumps, etc., that can be cyanided at a profit with a minimum of equipment and technical direction but they are a rare exception and the attempted use of this process by rule-of-thumb will almost always end in failure.

One of the recent cyanide plants constructed in California is that of the Mountain Copper Co., at Matheson, Shasta County. Its construction and operation are described by Charles V. Averill[1] in 'Mining in California,' April, 1931, quarterly chapter of State Mineralogist Report XXVII. Another interesting description of a cyanide leaching plant operating on tailings from the Yellow Aster Mine at Randsburg is given by C. R. Forbes in *Engineering & Mining Journal*, New York, March, 1934. The unusual features here are the use of long rectangular tanks instead of the usual round ones and the loading and unloading of the tanks with a slack-line drag scraper.

Smelting of gold ores, concentrates, etc., will not be discussed further than to mention an oil-burning furnace known as the *Kekich Roasting, Smelting and Converting Furnace,* which has been designed for equipment at individual mines. It is stated to handle 2 tons per 24 hours at an operating cost of $1.75 a ton. Several experimental runs were made with one in South San Francisco.

The *Mace Furnace* is another ore smelting furnace made in small units, which has been on the market for years.

Addresses will be furnished upon request.

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[1] District Mining Engineer, Redding Field Division.

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The publications are generally given with full title, following the names of the authors, which are arranged in alphabetical order. The general arrangement of the bibliography is:

I. Placer Resources
II. Placer Mining Methods
III. Prospector's Handbooks
IV. Miscellaneous

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* Available for consultation at principal libraries.
† Obtainable from the Superintendent of Documents, Washington, D. C.
‡ Obtainable from Publications Section, U. S. Bureau of Mines, Washington, D. C.
§ Obtainable from Publisher.
° Obtainable from the State Division of Mines, Ferry Bldg., San Francisco, and its branch offices at State Bldg., Los Angeles; State Office Bldg., Sacramento; Chamber of Commerce, Redding. Also from State Division of Oil and Gas at Bank of Italy Bldg., Bakersfield; San Marcos Bldg., Santa Barbara; Taft, Coalinga and Santa Paula.
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ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel

No changes in personnel to be noted during the past three months.

New Publications

'California Journal of Mines and Geology,' (quarterly), July and October, 1933, being Chapters 3 and 4 (combined) of the State Mineralogist's Report XXIX; price 80 cents, plus 10 cents postage. Contains: 'Gold Resources of Kern County'; 'Limestone Deposits of the San Francisco Region'; 'Limestone Weathering and Plant Associations of the San Francisco Region'; 'Booming'; 'Death Valley National Monument'; 'New State Legislation'.

January, 1934, being Chapter 1 of the State Mineralogist's Report XXX; price 40 cents, plus 5 cents postage. Contains: 'Resurrection of Early Surfaces in the Sierra Nevada'; 'Geology and Mineral Resources of Northwestern Madera County'; 'Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County'; 'Notes on Sampling as Applied to Gold Quartz Deposits'; 'Estimate of California's Mineral Production in 1933'.

Commercial Mineral Notes, Nos. 130–134 (inc.), February-June (inc.) 1934, respectively. These 'notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for "California Journal of Mines and Geology." As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to three pages in recent months.

Mails and Files

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

The counties of California have produced for some years past more than 50 different mineral substances, the total value of which for 1933 was estimated at $205,525,000. See January, 1934, issue of California Journal of Mines and Geology.

At present (April, 1934) reports for most of the producers are in hand. Data for several substances are now complete and have been compiled, being presented herein. Information at hand indicates that there was no production during 1933 of the following, which have, at one time or another in the past, been on our commercial list: arsenic, antimony, asbestos, bismuth, fluorspar, lepidolite, manganese ore, serpentine, shale oil, strontium, titanium and tin. There was a single producer in each of the following: bromine, carbon dioxide gas, feldspar, graphite, iodine, magnesite, mica, mineral paint, molybdenum, potash, wollastonite, and zinc.

It is interesting to note that in 1933 the first recorded commercial production of wollastonite was made. This material came from Code's Siding, Kern County, and was shipped to Los Angeles, where it was manufactured into mineral wool. Also, that carbon dioxide gas was on the active list, after being off the commercial list since 1896, and molybdenum having its first output since 1918.

BARYTES

During 1933 there was a commercial production of crude barytes in California amounting to a total of 8405 short tons valued at $49,595 f.o.b. rail-shipping point, as compared with the 1932 output of 8507 tons worth $49,409. The 1933 output came from Mariposa, Plumas and San Bernardino counties. This material was consumed in the manufacture of lithophone, in heavy gravity oil-well drilling mud-fillers, and barium chemicals.

BORATES

During 1933 there was produced in California a total of 191,006 tons of borate materials, compared with 202,950 tons for the year 1932. The material shipped during the year included the new sodium borates, kernite (rasorite), kramerite and some colemanite from Kern County; also crystallized borax prepared by evaporation of brines at Searles Lake in San Bernardino County and Owens Lake in Inyo County.

As the crude ore is not sold as such, but is almost entirely calcined before shipping to the refinery for conversion into the borax of commerce, and because of the fact that the material varied widely in boric acid content, we have recalculated the tonnage to a basis of 40 per cent, A. B. A. This is approximately the average A. B. A. content of the colemanite material after calcining, and also of the crystallized borax obtained from evaporation of the lake brines.

Recalculated as above, the 1933 production totaled 197,495 short tons valued at $3,019,513. This was an increase in both production and value over the 1932 output, which was 179,356 tons worth $2,856,470.

CEMENT

During 1933 there was a production in California of 7,284,031 barrels of cement valued at $10,331,375 f.o.b., being an increase in both quantity and value from that of the previous year. The 1932 output was $5,657,549 barrels worth $7,967,107 or an average value of $1.40 per barrel. The average value per barrel in 1933 was $1.42.

During 1933 shipments were made from eleven plants in nine counties to the extent of 7,369,947 barrels valued at $10,520,083, as compared to that of 1932, which was 5,853,155 barrels worth $8,202,038. The cement plants employed 1440 men in 1933. Two plants were operating and another making shipments from stock in San Bernardino County on hand and a single operating plant in each of the following counties: Calaveras, Contra Costa, Kern, Los Angeles,[1] Merced, Riverside, San Mateo and Santa Cruz.

CHROMITE

During the year 1932 and 1933 there were shipments of chromite in California amounting to 1206 short tons running 45% Cr_2O_3 worth $16,587. The annual details are given under the 'Unapportioned' item to conceal the output of a single producer in 1932. The 1933 shipments were the largest in volume since 1920, and a marked increase in both amount and value over the 1932 output.

COAL

Coal produced in California during 1933 totaled 2612 short tons valued at $11,367, as compared with the 1932 output, which was 9508 tons worth $36,468. The material mined in 1933 came from a single property in each, Amador, Monterey, and Trinity counties. This coal was consumed by the local market and also used on the property for camp purposes, power and forge, to carry on regular operations and development work.

DOLOMITE

The production of dolomite in California during 1933 was 54,456 short tons valued at $176,575 and came from three properties in Inyo County and one each in Los Angeles and Monterey counties. The 1933 output was an increase in both amount and value over that of 1932, which was 35,257 tons worth $40,956. The material shipped was utilized for steel surface flux and refractories, plaster, stucco dash-coat, terrazzo, art stone, and the manufacture of carbon dioxide.

GYPSUM

During the year 1932 there were shipments of gypsum in California amounting to 59,235 short tons valued at $120,451, coming from two properties in Riverside County and a single property each in Fresno and Imperial counties. This was an increase in both quantity and value from the 1932 output, which was 46,867 tons worth $93,718.

PUMICE AND VOLCANIC ASH

The production of pumice and volcanic ash in California during the year 1933 amounted to 8243 short tons valued at $61,067, coming from four properties in Inyo County and one each in Kern, Madera, Mono, Napa, San Bernardino and Siskiyou counties. The 1933 output showed a decrease from that of 1932, which was 9892 tons worth $86,034.

The material from three of the deposits in Inyo County and from Mono, Napa and Siskiyou counties was 3670 tons pumice and was used in acoustic plaster, light-weight aggregate in concrete, for abrasive purposes and for chicken-house litter. The product from one party in Inyo and that from Kern, Madera and San Luis Obispo counties was the 4573 tons of volcanic ash or tuff variety and was employed in making soap, cleanser compounds, a large tonnage being utilized as a concrete filler in cement displacement, and in asphalt and as a carrier for dry agricultural sprays. The Kern County ash is going into the preparation as one of our popular and nationally advertised brands of cleanser compounds.

SILICA (SAND AND QUARTZ)

We combine these materials because of the overlapping roles of vein quartz which is mined for use in glass making and as an abrasive, and that of silica sand which, although mainly utilized in glass manufacture, also serves as an abrasive. Both varieties are also utilized to some extent in fire-brick manufacture.

We do not include under this heading such forms of silica as: quartzite, sandstone, flint, tripoli, diatomaceous earth, nor the gem forms of 'rock crystal,' amethyst, and opal. Each of these has various industrial uses, which are treated under their own designations.

The production of silica in California during 1933 amounted to 69,599 short tons valued at $250,809 f.o.b. rail-shipping point, and came from two properties each in Contra Costa and Inyo counties and one each in El Dorado, Monterey, Orange, Riverside, and San Diego counties. The above was an increase in both amount and value as compared with the 1932 output, which was 33,997 tons worth $136,324. The 1933 output consisted of 68,591 tons of glass sand and 1008 tons of vein and boulder quartz.

The glass sand came from Contra Costa, Monterey, Orange and Riverside counties. For making the higher grades of glass, deposits in Contra Costa County is replacing the sand imported from Belgium. Belgium sand has displaced local material in the manufacture of sodium silicate ('water glass'). There are various deposits of quartz in California which could be utilized for glass making, but to date they have not been so used owing to the cost of grinding and the difficulty of preventing contamination by iron while grinding.

SLATE

The production of slate in California for 1933 was 5343 short tons valued at $31,958 f.o.b. rail shipping point and came from a single property in each of El Dorado, Inyo, and Tuolumne counties. The 1933 figures showed an increase in both amount and value over those of the previous year. The 1932 output was concealed under 'Unapportioned' so as not to reveal the yield of either operator for that year.

SODA

The production of sodium salts in California in 1933 included: Soda ash, trona, caustic soda and bicarbonate from plants at Owens Lake, Inyo County, and trona ('sesqui-carbonate,' a double salt of Na_2CO_3 and Na_2CO_3 and $NaHCO_3$) from Searles Lake, San Bernardino County. There were no shipments of salt cake (sulphate) from the Carrizo Plains, San Luis Obispo County, in 1933. The output of the year amounted to 70,598 short tons valued at $1,019,130, compared with the 1932 figures of 58,017 tons and $826,369.

The dense ash and bicarbonate were used mainly in the manufacture of soap, glass, paper, oil refining, sugar refining, and chemicals; and the trona for metallurgical purposes.

TALC AND SOAPSTONE

The total output of talc and soapstone in California during 1933 amounted to 14,451 short tons valued at $153,668. This was an increase in both quantity and value over the 1932 figures, which were 10,690 tons and $122,880. Of the 1933 production 12,704 tons were high-grade talc from Inyo and San Bernardino counties, which material was utilized mainly in toilet powders, paint, paper and rubber manufacture, and some in ceramics. The remainder of 1,748 tons was soapstone and came from Butte, El Dorado and Los Angeles counties.

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

The exhibit is raily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Beside its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

During 1933 there were 54,825 people who visited the Museum and Library of the Division of Mines in San Francisco. Among these there were many men who were forced by conditions to find new means of livelihood, and resorted to prospecting. They were able to observe here how all minerals, ores and rocks appear, thereby having a better knowledge of what they will find in the hills; also what minerals and rocks look like as described in various reports and books.

LABORATORY

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpose of identifying minerals and making qualitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this State department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is often able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector. Very small pieces of certain silicates, such as andalusite, have been supplied to those desiring them.

Determinations made by the Division of Mines during 1933 totaled 6498. Prospecting and exploitation of the State's mineral wealth increases as the State becomes more hickly populated. Each year new occurrences of some mineral in the State are reported and occasionally a new mineral species is found New uses for a mineral are frequently found, and as a result stimulus is given to searching for that particular substance

In the present economic distress many are seeking through hand methods of placer mining the wherewithal to purchase even food for themselves Besides some 10,000 separate pieces of printed matter covering such information supplied through the offices of the Division of Mines, a total of 1200 persons were taught and had demonstrated the rudiments of placering last year in the laboratory of the Division in San Francisco

LIBRARY

HERBERT A. FRANKE, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly beig issued in the form of reports and bulletis by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED

Government, National

U. S. Geological Survey:
  Bulletins:
    844C—The Suslota Pass District, Upper Copper River Region, Alaska. By F. H. Moffit.
    844D—Mineral Deposits of the Rampart and Hot Springs Districts, Alaska. By J. B. Mertie, Jr.
    844E—Reconnaissance of the Northern Koyukuk Valley, Alaska. By R. Marshall.
    846C—The Climax Molybdenum Deposits, Colorado. By B. S. Butler and J. W. Vanderwilt.
    846D—Some Lode Deposits in the Northwestern Part of the Boise Basin, Idaho. By C. P. Ross.
    848 —The Microscopic Determination of Nonopaque Minerals (Second Edition). By Larsen & Berman.
    849G—The Girdwood District, Alaska. By C. F. Park, Jr.
    857A—Mineral Industry of Alaska in 1932. By P. S. Smith.
    857B—Past Placer—Gold Production from Alaska. By P. S. Smith.
    858 —Bibliography of North American Geology, 1931 and 1932. By J. M. Nickles.

Water Supply Papers:

726—Part 1—North Atlantic Slope Basins.
727—Part 2—South Atlantic Slope and Eastern Gulf of Mexico Basins.
733—Part 8—Western Gulf of Mexico Basins.
737—Part 12—North Pacific Slope Basins.
739—Part 12—North Pacific Slope Basins.

U. S. Geological Survey:
Circulars:

5 —Geology of the North and South McCallum Anticlines, Jackson County, Colorado, with special reference to Petroleum and Carbon Dioxide. By J. C. Miller.
6 —Mineral-Water Supply of the Mineral Wells Area, Texas. By S. F. Turner.
7 —Gold-Quartz Veins South of Libby, Montana. By R. Gibson.
8 —Beach Placers of the Oregon Coast. By J. T. Pardee.

U. S. Bureau of Mines:
Bulletins:

369—Explosion Tests of Pittsburgh Coal Dust in the Experimental Mine, 1925 to 1932, incl. By Rice, Greenwald & Howarth.
370—Iron Oxide Mineral Pigments of the U. S. By H. Wilson.
376—Quarry Accidents in the U. S., 1932. By W. W. Adams.
377—Metal-Mine Accidents in the U. S., 1932. By W. W. Adams.

Report of Investigations:

3223—Progress Reports, Metallurgical Division, 1. Mineral Physics Studies. By R. S. Dean, V. H. Gottschalk, John Gross, J. Koster, C. W. Davis and C. E. Wood.
3224—Classification and Tabling of Alabama Red Iron Ores. By B. W. Gandrud, A. C. Richardson, and B. S. Followill.
3225—The Flotation of Alabama Graphite Ores. By B. W. Gandrud, G. D. Coe, C. S. Benefield, and I. N. Skelton.
3226—Progress Reports, Metallurgical Division, 2. Gold Recovery Studies. By E. S. Leaver, J. A. Woolf, and R. E. Head.
3227—Trade Trends in the Lime Industry. By Paul Hatmaker.

Information Circulars:

6754—Explosions in Kentucky Coal Mines, January 1, 1884-June 30, 1933. By J. F. Davies and H. B. Humphrey.
6757—Review of Fine Grinding in Ore Concentrators. By Alexander M. Gow, Morris Guggenheim and Will H. Coghill.
6760—Explosions in New Mexico Coal Mines, 1895 to 1932. By G. M. Kintz.
6761—Mine Explosions and Fires in the U. S. During the Fiscal Year ended June 30, 1933. By D. Harrington and W. J. Fene.
6762—Operating Coal Mines Without Accidents. By D. Harrington and W. J. Fene.
6763—Accident Experience and Cost in Virginia Coal Mines, 1929 to 1933, inclusive. By Joseph F. Davies and H. B. Humphrey.
6764—Explosions in Illinois Coal Mines, 1883 to 1932. By C. A. Herbert.
6765—Wyoming Coal-Mine Explosions. 1881–1931. By G. M. Kintz.
6766—Explosions in Virginia Coal Mines, 1839 to 1933. By Joseph F. Davies and H. B. Humphrey.
6767—Use of Airplanes in Mining and Petroleum Operations (Abstract). From an unpublished Bulletin Manuscript. By Hugh M. Wolflin. (Abstracted by Chas. Will Wright.)
6773—Silver Yield from Copper Ores and the Effects of 64.64-cent silver on the Value of Copper Ores Produced in the United States. By Elmer W. Pehrson.
6774—Leasing System as applied to Metal Mining. By W. O. Vanderburg.
6776—Lead and Zinc Mining and Milling in the United States Current Practices and Costs. (Abstract.) By Chas. F. Jackson, John B. Knaebel and C. A. Wright. (Abstracted by Chas. F. Jackson.)
Underground Scraping Practice in Metal Mines. By C. F. Jackson.

U. S. War Department:
Report of the Chief of Engineers, U. S. Army, 1933.

U. S. Geographic Board:
Sixth Report, 1890 to 1932.

Government, State

Arizona Bureau of Mines, Tucson:
  Bulletin 135—Arizona Gold Placers and Placering.
California State Department of Public Works, Sacramento:
  "California Highways and Public Works."
California State Division of Fish and Game, San Francisco:
  "California Fish and Game."
California State Library, Sacramento:
  "News Notes."
Idaho Inspector of Mines, Boise:
  35th Annual Report of the Mining Industry of Idaho, 1933.
Indiana Dept. of Conservation:
  15th Annual Report.
Nevada State Bureau of Mines, Reno:
  Vol. XXVIII, No. 2—Geology of the Tungsten Deposits near Mill City, Nevada. By P. F. Kerr.
New Jersey Department of Conservation and Development, Trenton:
  Bull. 41—Mineral Industry of New Jersey for 1932. By M. E. Johnson.
Texas Bureau of Economic Geology, Austin:
  3001—Contributions to Geology, 1930.
  3016—Geology of Bell Co., Texas. By Adkins & Arick.
  3019—Calcareous Foraminifera in the Brownwood Shale near Bridgeport, Texas. By H. J. Plummer. Foraminifera of the Cisco Group. By Cushman & Waters.
  3027—Geology of Stonewall Co., Texas. By L. T. Patton.
Texas Bureau of Economic Geology, Austin:
  3125—Geology of Grayson Co., Texas. By F. M. Bullard.
  3201—Contributions to Geology, 1932.
  3232—Geology of Texas—Stratigraphy. By Sellards, Adkins & Plummer.

Government, Foreign

Alberta Research Council, Edmonton:
  Annual Reports.
Argentina Direccion General de Minas y Geologica, Buenos Aires:
  Publications.
South Australia Department of Mines, Adelaide:
  Annual Reports, Mining Reviews, etc.
Canada Department of Mines, Ottawa:
  2128—Oil and Gas in Western Canada. (Second Edition.) By G. S. Hume
  Annual Report for 1932.
  Mineral Industries of Canada, 1933. By A. H. A. Robinson.
Geological Survey of Great Britain, London:
  Memoirs, Geologic Maps, etc.
Museo de Historia Natural de Montevideo, Uruguay:
  Analas.
Secretaria de Industria, Comercio y Trabajo, Mexico, D. F.:
  Boletin Minero.
  Boletin del Petroleo.
New Zealand Geological Survey Branch, Wellington:
  Reports.
Nova Scotia Department of Public Works and Mines, Halifax:
  Annual Reports.
Ontario Department of Mines, Toronto, Canada:
  Annual Reports.
  Bull. 80—Money and the World Crisis. By H. S. Denny.
  Forty-second Annual Report.
Quebec Bureau of Mines, Quebec, Canada:
  Reports.
  Annual Report, 1932.
Queensland Department of Mines, Brisbane, Australia:
  Annual Reports.
Instituto Historica e Geographico, Brasilerio de Janeiro:
  Publications.
New South Wales Department of Mines, Sydney, Australia:
  Annual Reports.
Transvaal Chamber of Mines, Johannesburg, So. Africa:
  Publications.
Geological Service of Minas Geraes, Bello Horizonte, Brazil:
  Publications.
Geological Survey of Scotland:
  Maps of the Fife Coalfields, Area II.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain:
  Memoiras.
Academy of Natural Sciences of Philadelphia:
  Proceedings.
American Association of Petroleum Geologists, Tulsa, Oklahoma:
  Bulletins.
American Geographical Society of New York:
  "Geographical Review."
  American Journal of Science, New Haven, Conn.
American Philosophical Society, Philadelphia:
  Proceedings.
Australian Museum, Sydney.
  Records.
California Academy of Sciences, San Francisco:
  Proceedings.
Canadian Institute of Mining and Metallurgy, Montreal:
  "Canadian Mining and Metallurgical Bulletin."
Cleveland Museum of Natural History, Cleveland, Ohio:
  Scientific Publications.
Colorado College Publication, Colorado Springs.
Colorado Scientific Society, Denver:
  Proceedings.
Commonwealth Club, San Francisco:
  Journals.
Economic Geology, Lancaster, Pa.
Field Museum of Natural History, Chicago:
  Geological Series.
Franklin Institute of the State of Pennsylvania, Lancaster, Pa.:
  Journals.
Geological Society of America, Columbia University, New York:
  Bulletins.
Geological Society of London:
  Abstracts of the Proceedings.
Institution of Mining and Metallurgy, London:
  Bulletins, Transactions.
Instituto Geologico de Mexico, Mexico, D. F.:
  Bulletins.
Journal of Geology, Chicago.
Library of Congress, Washington, D. C.:
  Monthly Check List of State Publications.
Mineralogical Society of America, Menasha, Wisconsin:
  "The American Mineralogist."
Mining and Metallurgical Society of America, New York:
  Bulletins.
Museu Nacional, Rio de Janeiro:
  Boletins.
National Research Council, Washington, D. C.:
  No. 51—Radioactivity. By Kovarik & McKeedan.
  No. 85—Physics of the Earth—V—Oceanography.
  No. 90—Physics of the Earth—VI—Seismology.
  Problems of Batholiths.
  Color Chart for the Description of Sedimentary Rocks.
  Annual Report for 1932–1933.
New York Academy of Sciences, New York:
  Annals, etc.
New York State Museum, Albany:
  Publications.
Northwest Scientific Association, Cheney, Wash.:
  "Northwest Science."
Pennsylvania State College, State College:
  Bulletins.
Philippine Journal of Science, Manila.
Royal Society of South Australia, Adelaide:
  Transactions and Proceedings.
Seismological Society of America, Stanford University:
  Bulletins.
Sierra Club, San Francisco:
  Bulletin.
Society of Economic Paleontologists and Mineralogists, Ft. Worth, Texas:
  "Journal of Paleontology."
Southern California Academy of Sciences, Los Angeles:
  Bulletins.

Stanford University, California:
  Abstracts of Dissertations.
Texas Technological College, Lubbock:
  Bulletins.
University of California Publications in Geography, Berkeley:
  Vol. 6, No. 5—Graphic Studies in Climatology. By J. B. Leighly.

Books and Pamphlets

Principles of the Hydro-Metallurgy and Electrodeposition of the Metals. By T. P. Campbell.
A Functional Size-Analysis of Ore Grinds. By A. J. Weinig.
Interviews with Mining Engineers. By T. A. Rickard.
Profitable Mine and Plant Practice.
Chemical Engineers Plant Notebook.
Metallurgical Spectrum Analysis. By W. J. Crook.
Mineral Oils. By Nash & Bowen.
Heat Transfer for Fluids in Turbulent Flow in Pipes. By R. Chandler.
Salt Domes. By R. V. Browne.
Halogens and Halogen Compounds in Heat Treatment of Hydrocarbons. By Nash and Mason.
John Hays Hammond Public Mining Library:
  Our Stone-Pelted Planet. By H. H. Nininger.
  Historic Spots in California, Valley and Sierra Counties. By Rensch & Hoover.

Maps

U. S. Geological Survey, Topographic:
  California:
    Chatom Ranch Quadrangle, Kings County.
    El Rico Ranch Quadrangle, Kings County.
    Guijarral Hills Quadrangle, Fresno County.
    Huron Quadrangle.
  Texas:
    Paso Real Quadrangle.
  Washington:
    Colville Quadrangle.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Commonwealth, San Francisco.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Geophysical Prospector, Los Angeles.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pa.
Mining Congress Journal, Washington, D. C.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining Truth, Spokane, Washington.
National Sand and Gravel, Washington, D. C.
Nickel Cast Iron News, New York City.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.

Oregon Mineralogist, Portland, Ore.
Pit and Quarry, Chicago.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Colusa Sun-Herald, Colusa, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inland Oil Index, Casper, Wyoming.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining & Industrial News, San Francisco, California.
Mojave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
National Industrial Review, San Francisco, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Northern Miner, Toronto, Canada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by the Bureau to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Coalinga, Taft, Bakersfield. They may also be found in many public, private and technical libraries in California and other States and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00	$0.20
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:		
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50	.10
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----	----
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**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----	----
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Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.50	.05
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----	----
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.65	.10
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	Price	Shipping Charges
**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917–1918, Fletcher Hamilton:		
Mines and Mineral Resources of Nevada County, 270 pp., paper	$0.75	$0.15
Mines and Mineral Resources of Plumas County, 188 pp., paper	.50	.10
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50	.10
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75	.25
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:		
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	.25	.05
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.25	.05
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California.' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25	.05
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.25	.05
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July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.25	.10
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Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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**October, 1926, Mines and Mineral Resources of El Dorado and Inyo Counties, also report on Minaret District, Madera County	----	----
Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1927, Mines and Mineral Resources of Contra Costa County; Santa Catalina Island	.25	.10
April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.25	.05
July, 1927, Mines and Mineral Resources of Placer and Los Angeles Counties	.25	.10
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Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.25	.05
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.25	.05
Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		

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**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00	$0.20
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----	----
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Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50	.10
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1915–1916. Fletcher Hamilton:		
**Mines and Mineral Resources, Alpine, Inyo and Mono Counties, 176 pp., paper	----	----
Mines and Mineral Resources, Butte, Lassen, Modoc, Sutter and Tehama Counties, 91 pp., paper	.50	.05
**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----	----
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.65	.10
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----	----
**Mines and Mineral Resources, San Bernardino and Tulare Counties, 186 pp., paper	----	----

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**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917–1918, Fletcher Hamilton:		
Mines and Mineral Resources of Nevada County, 270 pp., paper	$0.75	$0.15
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Mines and Mineral Resources of Sierra County, 144 pp., paper	.50	.10
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75	.25
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:		
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	.25	.05
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.25	.05
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25	.05
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1925, Mines and Mineral Resources of Sacramento, Monterey and Orange Counties	.25	.05
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July, 1925, Mines and Mineral Resources of Del Norte, Humboldt and San Diego Counties	.25	.10
**October, 1925, Mines and Mineral Resources of Siskiyou, San Luis Obispo and Santa Barbara Counties	----	----
Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
**January, 1926, Mines and Mineral Resources of Trinity and Santa Cruz Counties	----	----
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Chapters of Twenty-third Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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April, 1927, Mines and Mineral Resources of Amador and Solano Counties	.25	.05
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October, 1927, Mines and Mineral Resources of Mono County	.25	.05
Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
January, 1928, Mines and Mineral Resources of Tuolumne County	.25	.05
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July, 1928, Mines and Mineral Resources of Butte and Tehama Counties	.25	.05
October, 1928, Mines and Mineral Resources of Plumas and Madera Counties	.25	.05
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**January, 1929, Mines and Mineral Resources of Lassen, Modoc and Kern Counties; also on Special Placer Machines	----	----
April, 1929, Mines and Mineral Resources of Sierra, Napa, San Francisco and San Mateo Counties	$0.25	$0.10
July, 1929, Mines and Mineral Resources of Colusa, Fresno and Lake Counties	.25	.10
October, 1929, Mines and Mineral Resources of Glenn, Alameda, Mendocino and Riverside Counties	.25	.10
Chapters of Twenty-sixth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1930, Mines and Mineral Resources of Santa Clara County; also Barite in California	.25	.05
April, 1930, Mines and Mineral Resources of Nevada County; also Mineral Paint Materials in California	.25	.05
July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.25	.10
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.25	.10
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.25	.10
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.25	.10
July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County; its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	.25	.10
October, 1931. (Alpine.) Geology of the San Jacinto Quadrangle south of San Gorgonio Pass, California. Notes on Mining Activities in Inyo and Mono Counties in July, 1931	.25	.05
Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.25	.10
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	----	----
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits. Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.20	.05
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.50	.15

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Chapters of Report XXIX, 1933 (quarterly): titled "California Journal of Mines and Geology," containing the following:		
January-April. Gold Deposits of the Redding and Weaverville Quadrangles. Geologic Formations of the Redding-Weaverville District, Northern California. Geology of Portions of Del Norte and Siskiyou Counties. Applications of Geology to Civil Engineering. The Lakes of California. Discovery of Piedmontite in the Sierra Nevada. Tracing 'Buried River' Channel Deposits by Geomagnetic Methods. Geologic Map of Redding-Weaverville District, showing gold mines and prospects. Geologic Map showing various mines and prospects of part of Del Norte and Siskiyou Counties	$0.80	$0.15
July-October. Gold Resources of Kern County. Limestone Deposits of the San Francisco Region. Limestone Weathering and Plant Associations of the San Francisco Region. Booming. Death Valley National Monument, California. Placer Mining Districts, Senate Bill 480. Navigable Waters, Assembly Bill 1543	.80	.10
Chapters of Report XXX, 1934 (quarterly): titled "California Journal of Mines and Geology," containing the following:		
January. Resurrection of Early Surfaces in the Sierra Nevada. Geology and Mineral Resources of Northeastern Madera County. Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County. Notes on Sampling as Applied to Gold Quartz Deposits	.40	.10
April-July. Elementary Placer Mining in California and Notes on the Milling of Gold Ores	----	----
Subscription, $1.50 in advance (by calendar year, only).		
Chapters of State Oil and Gas Supervisor's Report:		
Summary of Operations—California Oil Fields, July, 1918, to March, 1919 (one volume)	Free	----
Summary of Operations—California Oil Fields. Published monthly, beginning April, 1919:		
**April, **May, **June, **July, **August, **September, **October, **November, **December, 1919	----	----
**January, **February, **March, **April, **May, **June, **July, **August, **September, **October, **November, **December, 1920	----	----
January, **February, **March, April, **May, **June, **July, August, **September, **October, **November, **December, 1921	Free	----
January, February, March, April, May, June, **July, **August, September, **October, **November, December, 1922	Free	----
January, February, **March, **April, May, **June, **July, August, September, **October, November, **December, 1923	Free	----
January, February, March, April, May, June, **July, August, September, October, November, December, 1924	Free	----
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**Bulletin No. 2. Methods of Mine Timbering, by W. H. Storms. 1894, 58 pp., 75 illustrations	----	----
**Bulletin No. 3. Gas and Petroleum Yielding Formations of Central Valley of California, by W. L. Watts. 1894, 100 pp., 13 illustrations, 4 maps	----	----
**Bulletin No. 4. Catalogue of Californian Fossils, by J. G. Cooper, 1894, 73 pp., 67 illustrations. (Part I was published in the Seventh Annual Report of the State Mineralogist, 1887)	----	----
**Bulletin No. 5. The Cyanide Process, 1894, by Dr. A. Scheidel. 140 pp., 46 illustrations	----	----
**Bulletin No. 6. California Gold Mill Practices, 1895, by E. B. Preston, 85 pp., 46 illustrations	----	----
**Bulletin No. 7. Mineral Production of California, by Counties, for the year 1894, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 8. Mineral Production of California, by Counties, for the year 1895, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 9. Mine Drainage, Pumps, etc., by Hans C. Behr. 1896, 210 pp., 206 illustrations	----	----
**Bulletin No. 10. A bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----	----
**Bulletin No. 11. Oil and Gas Yielding Formations of Los Angeles, Ventura and Santa Barbara Counties, by W. L. Watts. 1897, 94 pp., 6 maps, 31 illustrations	----	----
**Bulletin No. 12. Mineral Production of California, by Counties, for 1896, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 13. Mineral Production of California, by Counties, for 1897, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----	----
**Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----	----
**Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----	----
**Bulletin No. 17. Mineral Production of California, by Counties, for 1899, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 18. Mother Lode Region of California, by W. H. Storms. 1900, 154 pp., 49 illustrations	----	----
**Bulletin No. 19. Oil and Gas Yielding Formations of California, by W. L. Watts. 1900, 236 pp., 60 illustrations, 8 maps	----	----
**Bulletin No. 20. Synopsis of General Report of State Mining Bureau, by W. L. Watts. 1901, 21 pp. This bulletin contains a brief statement of the progress of the mineral industry in California for the four years ending December, 1899	----	----
**Bulletin No. 21. Mineral Production of California by Counties, by Charles G. Yale. 1900. Tabulated sheet	----	----
**Bulletin No. 22. Mineral Production of California for Fourteen Years, by Charles G. Yale. 1900. Tabulated sheet	----	----
Bulletin No. 23. The Copper Resources of California, by P. C. DuBois, F. M. Anderson, J. H. Tibbits and G. A. Tweedy. 1902, 282 pp., 69 illustrations, 9 maps	$0.50	$0.20
**Bulletin No. 24. The Saline Deposits of California, by G. E. Bailey. 1902, 216 pp., 99 illustrations, 5 maps	----	----
**Bulletin No. 25. Mineral Production of California, by Counties, for 1901, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 26. Mineral Production of California for the Past Fifteen Years, by Charles G. Yale. 1902. Tabulated sheet	----	----

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**Bulletin No. 27. The Quicksilver Resources of California, by William Forstner. 1903, 273 pp., 144 illustrations, 8 maps	----	----
**Bulletin No. 28. Mineral Production of California for 1902, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 29. Mineral Production of California for Sixteen Years, by Charles G. Yale. 1903. Tabulated sheet	----	----
**Bulletin No. 30. Bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by A. W. Vogdes. 1903, 290 pp.	----	----
**Bulletin No. 31. Chemical Analyses of California Petroleum, by H. N. Cooper. 1904. Tabulated sheet	----	----
**Bulletin No. 32. Production and Use of Petroleum in California, by Paul W. Prutzman. 1904, 230 pp., 116 illustrations, 14 maps	----	----
**Bulletin No. 33. Mineral Production of California, by Counties, for 1903, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 34. Mineral Production of California for Seventeen Years, by Charles G. Yale. 1904. Tabulated sheet	----	----
**Bulletin No. 35. Mines and Minerals of California, by Charles G. Yale. 1904, 55 pp., 20 county maps. Relief map of California	----	----
**Bulletin No. 36. Gold Dredging in California, by J. E. Doolittle. 1905. 120 pp., 66 illustrations, 3 maps	----	----
**Bulletin No. 37. Gems, Jewelers' Materials, and Ornamental Stones of California, by George F. Kunz. 1905, 168 pp., 54 illustrations	----	----
**Bulletin No. 38. Structural and Industrial Materials of California, by Wm. Forstner, T. C. Hopkins, C. Naramore and L. H. Eddy. 1906, 412 pp., 150 illustrations, 1 map	----	----
**Bulletin No. 39. Mineral Production of California, by Counties, for 1904, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 40. Mineral Production of California for Eighteen Years, by Charles G. Yale. 1905. Tabulated sheet	----	----
**Bulletin No. 41. Mines and Minerals of California for 1904, by Charles G. Yale. 1905, 54 pp., 20 county maps	----	----
**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 43. Mineral Production of California for Nineteen Years, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	----	----
**Bulletin No. 45. Auriferous Black Sands of California, by J. A. Edman. 1907. 10 pp.	----	----
**Bulletin No. 46. General Index of Publications of the California State Mining Bureau, by Charles G. Yale. 1907, 54 pp.	----	----
**Bulletin No. 47. Mineral Production of California, by Counties, 1906, by Charles G. Yale. Tabulated sheet	----	----
**Bulletin No. 48. Mineral Production of California for Twenty Years, by Charles G. Yale. 1906	----	----
**Bulletin No. 49. Mines and Minerals of California for 1906, by Charles G. Yale. 34 pp.	----	----
Bulletin No. 50. The Copper Resources of California, 1908, by A. Hausmann, J. Kruttschnitt, Jr., W. E. Thorne and J. A. Edman. 366 pp., 74 illustrations. (Revised edition)	$1.00	$0.25
**Bulletin No. 51. Mineral Production of California, by Counties, 1907, by D. H. Walker. Tabulated sheet	----	----
**Bulletin No. 52. Mineral Production of California for Twenty-one Years, by D. H. Walker. 1907. Tabulated sheet	----	----
**Bulletin No. 53. Mineral Production of California for 1907, with County Maps, by D. H. Walker. 62 pp.	----	----

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**Bulletin No. 55. Mineral Production of California for Twenty-two Years, by D. H. Walker, 1908. Tabulated sheet	----	----
**Bulletin No. 56. Mineral Production for 1908, with County Maps and Mining Laws of California, by D. H. Walker, 78 pp.	----	----
**Bulletin No. 57. Gold Dredging in California, by W. B. Winston and Chas. Janin. 1910, 312 pp., 239 illustrations, 10 maps	----	----
**Bulletin No. 58. Mineral Production of California, by Counties, by D. H. Walker. 1909. Tabulated sheet	----	----
**Bulletin No. 59. Mineral Production of California for Twenty-three Years, by D. H. Walker. 1909. Tabulated sheet	----	----
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**Bulletin No. 105. Mineral Production in California for 1930 and Directory of Producers	----	----
Bulletin No. 106. Manner of Locating and Holding Mineral Claims in California (with forms)	.25	----

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	Price	Shipping Charges
Bulletin No. 107. Mineral Production in California for 1931 and Directory of Producers	.25	.10
Bulletin No. 109. California Mineral Production and Directory of Mineral Producers for 1932, by Henry H. Symons, 200 pp. paper	.25	.10

PRELIMINARY REPORTS

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	Price	Shipping Charges
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**Preliminary Report No. 2. Notes on Damage by Water in California Oil Fields, March, 1914. By R. P. McLaughlin, 4 pp.	----	----
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Preliminary Report No. 5. Antimony, Graphite, Nickel, Potash, Strontium and Tin. By E. S. Boalich and W. O. Castello, 1918. 44 pp. Paper	Free	.05
**Preliminary Report No. 6. A Review of Mining in California During 1919. By Fletcher Hamilton, 1920. 43 pp. Paper	----	----
**Preliminary Report No. 7. The Clay Industry in California. By E. S. Boalich, W. O. Castello, E. Huguenin, C. A. Logan, and W. B. Tucker, 1920. 102 pp. 24 illustrations. Paper	----	----
**Preliminary Report No. 8. A Review of Mining in California During 1921, with Notes on the Outlook for 1922. By Fletcher Hamilton, 1922. 68 pp. Paper	----	----

MISCELLANEOUS PUBLICATIONS

**First Annual Catalogue of the State Museum of California, being the collection made by the State Mining Bureau during the year ending April 16, 1881. 350 pp.	----	----
**Catalogue of books, maps, lithographs, photographs, etc., in the library of the State Mining Bureau at San Francisco, May 15, 1884. 19 pp.	----	----
**Catalogue of the State Museum of California, Volume II, being the collection made by the State Mining Bureau from April 16, 1881, to May 5, 1884. 220 pp.	----	----
**Catalogue of the State Museum of California, Volume III, being the collection made by the State Mining Bureau from May 15, 1884, to March 31, 1887. 195 pp.	----	----
**Catalogue of the State Museum of California, Volume IV, being the collection made by the State Mining Bureau from March 30, 1887, to August 20, 1890. 261 pp.	----	----
**Catalogue of the Library of the California State Mining Bureau, September 1, 1892. 149 pp.	----	----
**Catalogue of West North American and Many Foreign Shells with Their Geographical Ranges, by J. G. Cooper. Printed for the State Mining Bureau, April, 1894	----	----
**Report of the Board of Trustees for the four years ending September, 1900. 15 pp. Paper	----	----
Bulletin. Reconnaissance of the Colorado Desert Mining District. By Stephen Bowers, 1901. 19 pp. 2 illustrations. Paper	$0.10	----
Commercial Mineral Notes. A monthly mimeographed sheet, beginning April, 1923	Free	.15 annually

MAPS

Register of Mines With Maps

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
Register of Mines, with Map, Amador County	$0.25	$0.05
Register of Mines, with Map, Butte County	.25	.05
**Register of Mines, with Map, Calaveras County	----	----
**Register of Mines, with Map, El Dorado County	----	----
**Register of Mines, with Map, Inyo County	----	----
**Register of Mines, with Map, Kern County	----	----
**Register of Mines, with Map, Lake County	----	----
**Register of Mines, with Map, Mariposa County	----	----
**Register of Mines, with Map, Nevada County	----	----
**Register of Mines, with Map, Placer County	----	----
**Register of Mines, with Map, Plumas County	----	----
**Register of Mines, with Map, San Bernadino County	----	----
**Register of Mines, with Map, San Diego County	----	----
Register of Mines, with Map, Santa Barbara County (1906)	.25	.05
**Register of Mines, with Map, Shasta County	----	----
**Register of Mines, with Map, Sierra County	----	----
**Register of Mines, with Map, Siskiyou County	----	----
**Register of Mines, with Map, Trinity County	----	----
**Register of Mines, with Map, Tuolumne County	----	----
Register of Mines, with Map, Yuba County (1905)	.25	.05
Register of Oil Wells, with Map, Los Angeles City (1906)	.35	.05

OTHER MAPS

**Map of California, Showing Mineral Deposits (50 x 60 in.)	----	----
**Map of Forest Reserves in California	----	----
**Mineral and Relief Map of California	----	----
**Map of El Dorado County, Showing Boundaries, National Forests	----	----
**Map of Madera County, Showing Boundaries, National Forests	----	----
**Map of Placer County, Showing Boundaries, National Forests	----	----
**Map of Shasta County, Showing Boundaries, National Forests	----	----
**Map of Sierra County, Showing Boundaries, National Forests	----	----
**Map of Siskiyou County, Showing Boundaries, National Forests	----	----
**Map of Tuolumne County, Showing Boundaries, National Forests	----	----
**Map of Mother Lode Region	----	----
**Map of Desert Region of Southern California	----	----
Map of Minaret District, Madera County	.20	.05
Map of Copper Deposits in California	.05	----
**Map of Calaveras County	----	----
**Map of Plumas County	----	----
**Map of Trinity County	----	----
**Map of Tuolumne County	----	----
Geological Map of Inyo County. Scale 1 inch equals 4 miles	.60	.05
**Map of California accompanying Bulletin No. 89, showing generalized classification of land with regard to oil possibilities. Map only, without Bulletin	----	----
Geological Map of California, 1916. Scale 1 inch equals 12 miles. As accurate and up-to-date as available data will permit as regards topography and geography. Shows railroads, highways, post offices and other towns. First geological map that has been available since 1892, and shows geology of entire state as no other map does. Geological details lithographed in 23 colors. Unmounted	.75	.05
Mounted	2.00	.15
**Topographic Map of Sierra Nevada Gold Belt, showing distribution of auriferous gravels, accompanying Bulletin No. 92. In 4 colors (also sold singly)	----	----

OTHER MAPS—Continued

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
Geologic Map of Northern Sierra Nevada, showing Tertiary River Channels and Mother Lode Belt, accompanying July-October Chapter of Report XXVIII of the State Mineralogist. (Sold singly)	$0.25	$0.05
Map of Northern California, showing rivers and creeks which produced placer gold in 1932	.20	.05

OIL FIELD MAPS

The maps are revised from time to time as development work advances and ownerships change.

	Price (including postage)
Map No. 1—Sargent, Santa Clara County	$0.50
Map No. 2—Santa Maria, including Cat Canyon and Los Alamos	1.00
Map No. 3—Santa Maria, including Casmalia and Lompoc	1.00
Map No. 4—Brea Olinda & (East Portion) Coyote Hills, Los Angeles and Orange Counties	1.00
Map No. 6—Salt Lake-Beverly Hills, Los Angeles County	1.00
Map No. 7—Sunset and San Emidio, Kern County	1.00
Map No. 8—South Midway and Buena Vista Hills, Kern County	1.00
Map No. 9—North Midway and McKittrick, Kern County	1.00
Map No. 10—Belridge and McKittrick Front, Kern County	1.00
Map No. 11—Lost Hills and North Belridge, Kern County	1.00
Map No. 12—Devils Den, Kern County	.75
Map No. 13—Kern River and Fruitvale, Kern County	1.00
Map No. 14—Coalinga, Fresno County	1.25
Map No. 15—Elk Hills, Kern County	1.00
Map No. 16—Ventura-Ojai, Ventury County	1.00
Map No. 17—Santa Paula–Sespe, including Bardsdale, South Mountain and Camarillo, Ventura County	1.00
Map No. 18—Piru-Simi-Newhall, Ventura County	1.00
Map No. 19—Arroyo Grande, San Luis Obispo County	.75
Map No. 20—Long Beach, Los Angeles County	1.50
Map No. 21—Portion of District No. 4, showing boundaries of oil fields—Kern and Kings Counties	.75
Map No. 21-A—Portion of District No. 4, showing boundaries of oil fields—Kern County	.75
Map No. 21-B—Portion of District No. 5, showing boundaries of oil fields—Fresno, Kings and Kern Counties	.75
Map No. 22—Portion of District No. 3, showing boundaries of oil fields—Santa Barbara County	.75
Map No. 23—Portion of District No. 2, showing boundaries of oil fields—Ventura County	.75
Map No. 24—Portion of District No. 1, showing boundaries of oil fields—Los Angeles and Orange Counties	1.00
Map No. 26—Huntington Beach, Orange County	1.25
Map No. 27—Santa Fe Springs, Los Angeles County	1.00
Map No. 28—Torrance, Los Angeles County	1.00
Map No. 29—Dominguez, Los Angeles County	.75
Map No. 30—Rosecrans, Los Angeles County	.75
Map No. 31—Inglewood, Los Angeles County	1.00
Map No. 32—Seal Beach, Los Angeles and Orange Counties	1.00
Map No. 33—Rincon, Ventura County	1.00
Map No. 34—Mt. Poso, Kern County	.75
Map No. 35—Round Mountain, Kern County	.75
Map No. 36—Kettleman Hills, Fresno, Kings and Kern Counties	1.25
Map No. 37—Montebello, Los Angeles County	1.00
Map No. 38—Whittier, Los Angeles County	1.00
Map No. 39—West Coyote, Los Angeles and Orange Counties	1.00
Map No. 40—Elwood, Santa Barbara County	1.00
Map No. 41—Potrero, Los Angeles County	.75
Map No. 42—Playa del Rey, Los Angeles County	1.25
Map No. 43—Capitan, Santa Barbara County	.75
Map No. 44—Mesa, Santa Barbara County	1.25
Map No. 45—Buttonwillow gas, Kern County	.75
Map No. 46—Richfield, Orange County	1.00
Map No. 47—Mountain View, Kern County	.75

DETERMINATION OF MINERAL SAMPLES

Samples (limited to three at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

12676 8-34 2M

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES

DIVISION OF MINES

CORDIALLY INVITES YOU TO VISIT
ITS VARIOUS DEPARTMENTS MAINTAINED
FOR THE PURPOSE OF FURTHERING
THE DEVELOPMENT OF THE

MINERAL RESOURCES OF CALIFORNIA

At the service of the public are the scientific reference library and reading room, the general information bureau, the laboratory for the free determination of mineral samples found in the State, and the largest museum of mineral specimens on the Pacific Coast. The time and attention of the State Mineralogist, as well as that of his technical staff, are also at your disposal.

Office hours: 9 a.m. to 5 p.m. daily.
Saturday, 9 a.m. to 12 m.
(Except July and August, 8 a.m. to 4 p.m.)

WALTER W. BRADLEY,
State Mineralogist.

Third floor, Ferry Building, San Francisco, Cal.
Branch Offices: State Building, Los Angeles; State Office Building, Sacramento; Chamber of Commerce, Redding; Bank of Italy Building, Bakersfield; San Marcos Building, Santa Barbara: Taft. Coalinga and Santa Paula.

STATE OF CALIFORNIA
DEPARTMENT OF NATURAL RESOURCES
GEORGE D. NORDENHOLT, Director

DIVISION OF MINES
FERRY BUILDING, SAN FRANCISCO

WALTER W. BRADLEY State Mineralogist

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OF

MINES AND GEOLOGY

QUARTERLY CHAPTER
OF
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FERRY BUILDING, SAN FRANCISCO,
CALIFORNIA

CALIFORNIA STATE PRINTING OFFICE
HARRY HAMMOND, STATE PRINTER
SACRAMENTO, 1935

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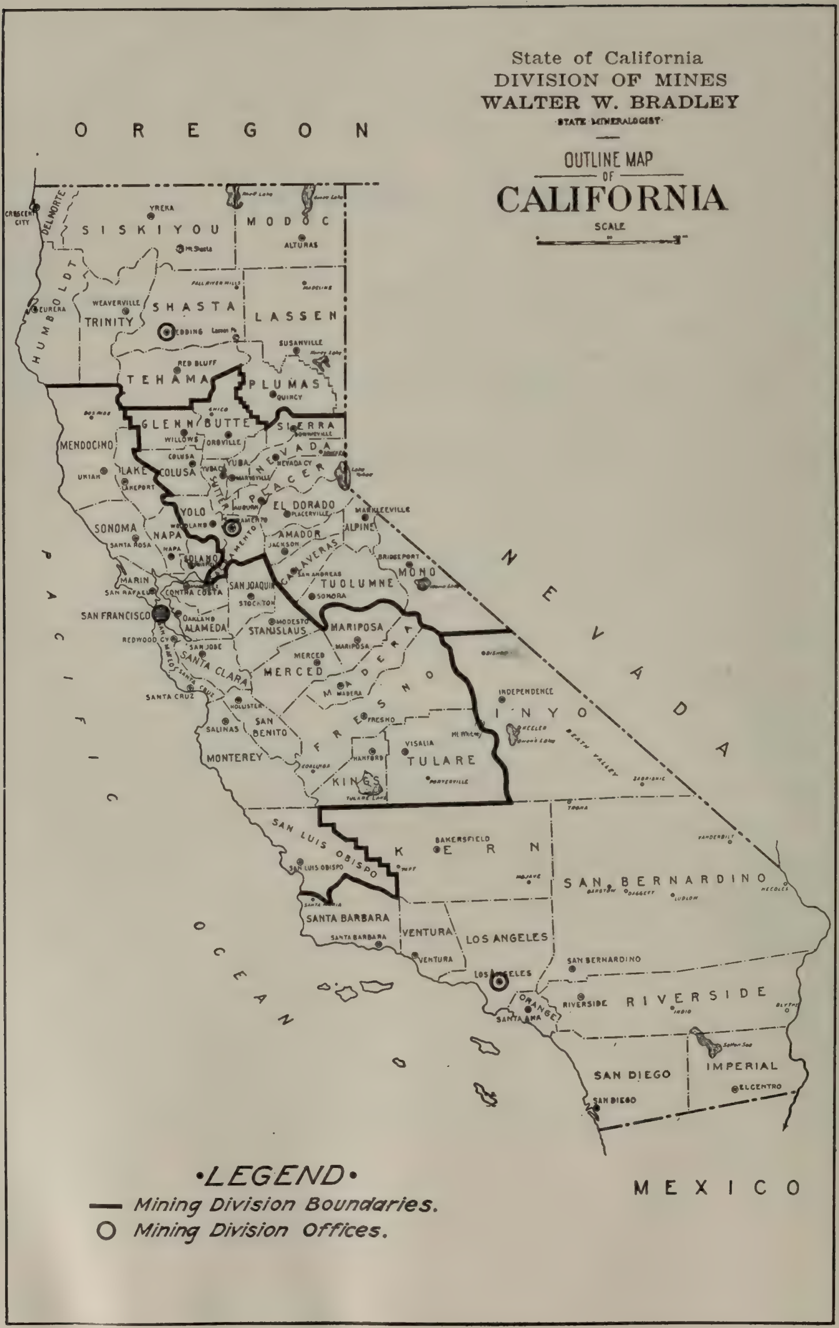


State of California
DIVISION OF MINES
WALTER W. BRADLEY
STATE MINERALOGIST

OUTLINE MAP
OF
CALIFORNIA

SCALE
OREGON
NEVADA
PACIFIC OCEAN
MEXICO
CRESCENT CITY
DEL NORTE
SISKIYOU
YREKA
Mt Shasta
MODOC
ALTURAS
HUMBOLDT
EUREKA
TRINITY
WEAVERVILLE
SHASTA
REDDING
Lassen Pk
LASSEN
SUSANVILLE
TEHAMA
RED BLUFF
PLUMAS
QUINCY
MENDOCINO
UKIAH
GLENN
WILLOWS
BUTTE
CHICO
OROVILLE
SIERRA
DOWNIEVILLE
NEVADA
NEVADA CY
COLUSA
LAKE
LAKEPORT
YUBA
MARYSVILLE
SUTTER
PLACER
AUBURN
EL DORADO
PLACERVILLE
MARKLEEVILLE
ALPINE
YOLO
WOODLAND
SACRAMENTO
SONOMA
SANTA ROSA
NAPA
AMADOR
JACKSON
SOLANO
CALAVERAS
SAN ANDREAS
BRIDGEPORT
MONO
MARIN
SAN RAFAEL
CONTRA COSTA
SAN JOAQUIN
STOCKTON
TUOLUMNE
SONORA
SAN FRANCISCO
OAKLAND
ALAMEDA
MODESTO
STANISLAUS
MARIPOSA
REDWOOD CY
SAN MATEO
SAN JOSE
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
HOLLISTER
SAN BENITO
SALINAS
FRESNO
INDEPENDENCE
INYO
Mt Whitney
KEELER
DEATH VALLEY
MONTEREY
COALINGA
HANFORD
KINGS
VISALIA
TULARE
PORTERVILLE
Tulare Lake
SAN LUIS OBISPO
BAKERSFIELD
KERN
MOJAVE
SAN BERNARDINO
BARSTOW
DAGGETT
LUDLOW
NEEDLES
SANTA MARIA
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
SANTA ANA
RIVERSIDE
INDIO
BLYTHE
SAN DIEGO
IMPERIAL
EL CENTRO
Salton Sea
•LEGEND•
Mining Division Boundaries.
Mining Division Offices.

PREFACE

The Division of Mines (formerly State Mining Bureau) is maintained for the purpose of assisting in all possible ways in the development of California's mineral resources.

As one means of offering tangible service to the mining public, the State Mineralogist for many years has issued an annual or a biennial report reviewing in detail the mines and mineral deposits of the various counties.

As a progressive step in advancing the interests of the mineral industry, and as permitting earlier distribution to the public, publication of the Annual Report of the State Mineralogist in the form of monthly chapters was begun in January, 1922, and continued until March, 1923. Owing to a lack of funds for printing this was changed to a quarterly publication, beginning in September, 1923. For the same reason, beginning with the January, 1924, issue, it became necessary to charge a subscription price. This covers approximately the cost of printing.

Pages are numbered consecutively throughout the year and an index to the complete report is included annually in the closing number.

Beginning with the 1930 issues, the activities and progress of the Geologic Branch are recorded also in these quarterly chapters. The important part that geology plays in the economic development of our mineral resources is further recognized in the change of title from *Mining in California* to CALIFORNIA JOURNAL OF MINES AND GEOLOGY, beginning with the January, 1933, chapter.

While current activities of all descriptions are covered in these chapters, the practice of issuing from time to time technical reports on special subjects will be continued as well. A list of such reports now available is appended hereto, and the names of new bulletins will be added in the future as they are completed.

The chapters are subject to revision, correction and improvement. Constructive suggestions from the mining public will be gladly received, and are invited.

The one aim of the Division of Mines is to increase its usefulness and to stimulate the intelligent development of the wonderful, latent resources of the State of California.

Types of Reports

In general the reports presented in these chapters are grouped into three classes:

1. Mines and mineral resources of a given County (describing kind, character, distribution and extent of development).
2. Specific economic and industrial mineral products (listing and describing the resources over the entire State of a given mineral substance, e.g. feldspar).
3. Geological reports on specific areas (recording results and conclusions, with maps, derived from field studies; and tied in with economic possibilities, and developments).

REPORTS OF DISTRICT MINING ENGINEERS

In 1919–1920 the Mining Bureau was organized into four main geographical divisions, with the field work delegated to a mining engineer in each district, working out from field offices that were established in Redding, Auburn, San Francisco and Los Angeles, respectively. This move brought the office into closer personal contact with operators, and it has many advantages over former methods of conducting field work, including lower traveling-expense bills for the Bureau's engineers. In 1923 the Redding and Auburn field offices were consolidated and moved to Sacramento.

The Redding office was reestablished in 1928, and the boundaries of each district adjusted. The counties now included in each of the four divisions and the locations of the branch offices are shown on the accompanying outline map of the State. (Frontispiece.)

Reports of mining activities and development in each district, prepared by the District Engineer, will continue to appear under the proper field division heading.

Although the petroleum industry is but little affiliated with other branches of mining, oil and gas are among the most valuable mineral products of California, and a report by the State Oil and Gas Supervisor on the current development and general conditions in the State's oil fields is included under this heading.

REDDING FIELD DISTRICT

CHAS. V. AVERILL, Mining Engineer

CURRENT MINING DEVELOPMENTS IN NORTHERN CALIFORNIA

LASSEN COUNTY

Diamond Mountain Mines, Inc., Geo. N. McDow, president, Susanville, is seven and a half miles southwest of Susanville. New development work has been done here recently advancing the lower tunnel to a total length of 440 feet. Crosscuts in several different places total 179 ft. in length. In one of these an 18-ft. width of quartz can be seen. According to George McDow, Jr., this width shows an assay value of $19 per ton with gold figured at $20 per ounce. A lease has been given on an entirely different part of this property, and two men are at work.

Golden Eagle, one of the old groups of the Hayden Hill district, is stated to be under option to *Hayden Hill Gold Corporation*, by R. H. Fritz, foreman of the latter (see below). Dumps of the Golden Eagle are being loaded by means of a scraper and double-drum hoist, then screened in a trommel. Larger sizes are discarded immediately, while sizes below five-eighths of an inch are leached with cyanide. Four men handle 100 to 125 tons per day of dump-rock under Austin Woods and W. L. Merrill of Adin.

Hayden Hill Gold Corporation, W. J. Stratton, president, Symons Building, Spokane, Washington, is operating the Blue Bell group at Hayden Hill. R. H. Fritz of Adin is in charge. Work on the 200-ft. level of the shaft is stated to have opened up a block of $6- to $20-ore, 60 ft. square, between this level and the 100-ft. level. An adit, 1000 ft. long, reaching the Evening Star shaft of the Golden Eagle group, was being cleaned out at the 400-ft. point at time of visit. A small production was being made in a test plant with a capacity of four tons in eight hours. This consists of a Straub ball mill, 18-hp. gasoline engine, and amalgamating plates. Ten men were employed at time of visit. Several new buildings had been built.

Juniper is a single patented claim at Hayden Hill, surrounded by claims of the Blue Bell group. H. P. Anderson, F. H. Brown and Geo. J. Harper, lessees, of Adin, are shipping 40 tons of excellent ore from the 70-ft. level every two weeks to the Selby smelter. Much of the ore at Hayden Hill consists of free gold in gouge- and ochre-seams. This good ore at the Juniper, however, contains much vein-quartz as well as gouge.

MODOC COUNTY

High Grade District. Prospecting in this old district is active, and small amounts of ore have recently been treated. One of these lots, containing not quite two tons, shipped by Wm. Larkens of Alturas, is stated to have given net smelter returns of $403 per ton.

Lost Cabin Mine, 28 miles from Alturas, near the new highway to Redding, is owned by A. K. Wylie of Alturas. A new mill with a capacity of one ton per hour has been built practically on the highway. It contains Kraut flotation cells and additional flotation equipment designed and installed by the operator, Wm. S. Howell. Operation of the mill is intermittent.

PLUMAS COUNTY

Bunker Hill Mine, a drift placer near La Porte, is being operated under the supervision of Charles Scott Haley of Quincy.

Indian Valley Mining Co. is operating the Standart mine, two miles from Greenville. G. L. Johnson is in charge. Ore is treated in a 10-stamp mill equipped with flotation cells.

Plumas County Mining Co. is opening up the old Indian Valley mine, two miles from Greenville. The Hammon Engineering Company is in charge of the work, with George I. Barnett as resident engineer.

Plumas Eureka Mine near Johnsville. Reports indicate that surface material is being mined here with a power shovel and treated by washing with good results. Three hundred cubic yards per day are said to yield 70¢ per yard.

SHASTA COUNTY

American Mine near French Gulch is being operated by *Abacada Mining Corporation,* George H. Proctor, Chairman of the Board, 50 Church Street, New York City. N. D. Bertram of French Gulch is general superintendent. A new 60-ton mill containing all new machinery has been built and is in operation. Machinery includes crushers, Marcy ball mills, amalgamator, Wifley table and six Denver 'Sub-A' (Fahrenwald) flotation cells. The 100-ft. winze below the No. 5 level has been pumped out and drifts extended from it to block out new ore. Sinking of an additional 100 ft. of the winze is also in progress.

Balaklala Mine is near Coram. Preliminary work looking to the working of gossan is under way. The road from Coram, which had been destroyed by the heavy erosion of that vicinity, has been rebuilt under the supervision of M. C. Dann of Kennett. He states that a cyanide plant similar to that of The Mountain Copper Co., but of smaller size, will be built.

Milkmaid Mine near French Gulch is being operated by *J. H. Scott Company* of French Gulch and of Merchants Exchange Building, San Francisco. The 10-stamp mill has been remodeled, and Kraut flotation cells have been added. In the mine, 1800 ft. of old workings have been cleaned out and retimbered where necessary; and rails and pipe have been laid. Several hundred feet of new drifts and crosscuts have been run. The mill has recently been started on a mixture of tailings and ore from the mine. Art Brown of French Gulch is in charge.

The Mountain Copper Company, Ltd., of Matheson continues to be the largest gold producer of northern California. The gossan ore is mined from open pits with power shovels, and leached with cyanide. Under the shupervision of Wm. F. Kett, general manager, of San Francisco, M. J. Murphy, general superintendent, and J. M. Basham, mill superintendent, the process has been constantly improved so that an excellent extraction is now obtained. The capacity of the plant has been increased to 700 tons per day. This plant was described in MINING IN CALIFORNIA for April, 1931, at which time the capacity was 550 tons per day. Pyrite has recently been shipped by this company from its Hornet mine at the rate of 250 tons per day. The company has recently purchased a large quartz property in El Dorado County, and this is now being equipped to operate on a large scale under the supervision of J. M. Basham.

Russell Mine is an extensive gravel deposit, apparently an old channel of Clear Creek, near Igo. Western Contracting Co., with Fred Galeno of Seattle, Wash., in charge, a short time ago was mining 1000 cubic yards here in 8 hours, and hauling it in trucks to a stationary washing plant. The larger boulders were taken away from this plant in trucks also. Apparently this method was found to be too expensive, and efforts are now being made to put the property in operation as a hydraulic mine.

SISKIYOU COUNTY

Classic Hill Mine is on Indian Creek, 11 miles by road north of Happy Camp, and is assessed to C. Scott Greening of Happy Camp. Wason & Riley of Seattle, Wash., are equipping the property for operation with Al. Hahn as superintendent. The lower ditch, six miles long, is being repaired and flumes are being rebuilt. When this work is completed, it is planned to build a sawmill at the mine. Lumber will then be available to complete the upper ditch and flume, nine miles long.

Commodore Mine is on Barkhouse Creek, 30 miles from Yreka. Several hundred feet of new development work have just been done here under the supervision of William L. Merritt, *Acme Engineering Service,* Railway Exchange Building, Portland, Oregon.

Gardella Dredge with 5-cubic-foot buckets has been operating for the past two years just south of Yreka on the east side of the highway

Gold Ball Mining Co. is operating on the *Stevens group* in Eddys Gulch near Sawyers Bar. F. A. Gowing, Sawyers Bar, is president and general manager. A. F. Chapman, c/o James Allen, Yreka, is secretary. A 25-ton mill containing crusher, Marcy ball mill, amalgamating plates and two Kraut flotation cells is in operation. Power is furnished by a 100-hp. Diesel engine. The ore is white quartz mined from a flat vein. Bands of black schist occur in the quartz, and much graphite from these appears in the flotation concentrates.

Gravel Mines, Ltd., is a hydraulic mine on a high terrace of the Klamath River at China Creek, about 10 miles east of Happy Camp. C. C. Broadwater, 27 Highland Avenue, Piedmont, is president, and J. C. Moulton of Seiad is in charge of the mine. Water is brought in from China Creek through 5400 ft. of ditch, and 4200 ft. of new flume. The capacity is 1000 miner's inches with 175 ft. of head at the mine. The mine is completely equipped to operate during the coming water-season.

Hansen Mines (Cosmos Mines Development Company) is a quartz mine, eight and a half miles by trail southwest of Forks of Salmon. It is being operated by a crew of about 10 men under Ralph Bender. A mill, said to be of 30 tons capacity, is in operation.

King Solomon Mines Co., Roy N. Bishop, president, 411 Crocker Building, San Francisco, is operating the old King Solomon Mine, eight miles south of Black Bear. Harry M. Thompson of Black Bear is in charge. From Black Bear a new road has been built to the mine, following in a general way the old trail. An unusual method of prospecting was used here, large trenches being cut through the deposit with road-building machinery, plow and bulldozer (caterpillar tractor with scraper blade in front). These trenches were then very carefully sampled and assayed in a new assay office at the mine. A 300-ton mill was then built, and has been in operation for about two years. The soft surface-ore is ground in two Hardinge pebble mills, treated on amalgamating plates, then in flotation cells. It is now planned to replace the latter with a cyanide process. Mining is done with a Diesel shovel; and ore is delivered to the mill with a 2500-ft. aerial cable-tram.

Lanky Bob and Slim Jim, quartz mines in Whites Gulch near Sawyers Bar, are leased to Joseph T. Sugars, H. W. A. Docker, Harry Summers and Frank Cantril of Sawyers Bar. These men, with the help of other miners in the vicinity and the U. S. Forest Service, have recently built two miles of road to the mine. They are operating a two-stamp mill, followed by an Ellis mill. Treatment is amalgamation followed by flotation in three home-made cells. Ore comes from an adit on a 2-ft. quartz vein, at an elevation 250 ft. higher than the mill.

Lowden Mine is an old placer (hydraulic) near Seiad. A ditch, two and a half miles long, from Seiad Creek was reconditioned more than a year ago, and pipe was installed to give 1200 miner's inches of water at the mine under 100-ft. head. A little mining was done. Later the property was reported to be optioned to T. L. Park of Seiad, who states that he controls 452½ acres in the vicinity, and that he is preparing to mine.

Mayland Mining Co. (not incorporated), A. H. Mayland, Calgary, Alberta, Canada, is operating the *White Bear Mine,* about two miles from Black Bear post office, with Arthur J. Theis of Sawyers Bar in charge. The mill has just been remodeled. It contains crushers, Straub 4-ft. by 3-ft. rib-cone ball mill and Dorr classifier. Treatment is amalgamation followed by flotation in two Kraut cells and two American Cyanamid (Fagergren) cells. A 4-ft. quartz vein is developed by adits, on the lowest of which there is 700 ft. of drifting. Country rock is a graphitic schist; and much graphite from bands of this in the vein appears in the flotation concentrate. The property is well equipped with buildings, compressor and tools.

Quartz Hill Mine at Scott Bar is now being operated under a lease by George Noonan of Scott Bar and George A. Milne of Fort Jones. The quartz veins and hard schist are blasted and then a hydraulic giant is turned on the broken material and it is washed through a sluice, as in the past. Newly broken faces are searched for pockets. Some consideration is now being given to milling the ore.

Queen of Sheba is a property near Callahan being developed by Goldberg and Sullivan, c/o Abe Goldberg, Etna. Surface ore is being prospected with the same methods used at King Solomon. Trenches, 12 ft. wide and as much as 20 ft. deep, are excavated with road-building machinery, plow and bulldozer (60-hp. Diesel Caterpillar tractor with scraper blade in front). Hard rock is found only a few feet below the surface here, and it requires blasting. A 30-ton test plant consisting of ball mill, classifier and amalgamator has been built. Ore for this is loaded on trucks with a ¾-yard Thew gasoline shovel. Samples from the trenches are assayed on the property in a new assay-office.

Reeve Ranch comprises 280 acres of placer gravel on a low terrace of the Klamath River near Happy Camp, owned by Miss M. A. Reeve, 729 Oak Street, San Francisco, California. It is leased to James T. Logan of Happy Camp, who is operating it as a hydraulic mine with a hydraulic elevator. A ditch from Indian Creek, 2¼ miles long, carries 30 cubic feet per second, with an 80-ft. head at the mine. Two giants with 3-inch nozzles deliver gravel to the hydraulic elevator with 10-inch throat opening; and the gravel is raised 14 ft. vertically.

Logan states that he is handling 1000 cu. yd. per 24 hours of gravel containing 30¢ to 60¢ per yard in gold (gold @ $20).

Seiad Placer Mines, a copartnership. See Lowden Mine above.

Victory Gold Mines, three miles by road from Finley Camp, has recently been owned by John Nefroney of Etna. At time of visit in August, 1934, Nefroney was personally operating a new mill of a rated capacity of 24 tons in 24 hours. Ore was ground in a rod mill and treated by amalgamation only; although the mill contains concentrating tables of the Wilfley type. Power was furnished by a 72-kw. hydroelectric generator installed two years ago. Shortage of water for this, limited operations to only a part of the day. Nefroney stated that he did not have time to show the mine. Ore for the mill was being delivered on mule-back. The property is reported to have changed hands recently.

White Bear Mine. See Mayland Mining Co. above.

TRINITY COUNTY

Brown Bear Mine is just across the county line from the French Gulch district of Shasta County, and is really in an extension of the latter. It is operated with a crew of from 15 to 20 men under E. E. Erich of French Gulch. The 10-stamp mill has been operated intermittently during the past two years.

Canyon Placers, Inc., A. J. Brandt, president, 416 Stormfeltz-Loveley Building, Detroit, Michigan, controls 1500 acres of terrace gravels of Canyon Creek near Dedrick. The Grotefend, Dannenbrink, Clarke and other properties have been consolidated so that the company controls channels of a total length of about five miles, separated into two approximately equal segments, one near Dedrick, the other about two miles below. The new water system consists of 20,000 ft. of ditch and flume from the main Canyon Creek and 6000 ft. of ditch and flume from the Big East Fork. The first has a capacity of 4000 miner's inches, the second has a capacity of 2000 inches; and they feed a 1,000,000-gallon reservoir. For syphons, and to reach the mine, 4600 ft. of 40- and 30-inch pipe was installed. The head is nearly 400 ft. During the past water-season, the upper pit was operated practically continuously for 24 hours per day. The lower pit was operated part time with a smaller water supply from Gwynn and Rarrick gulches.

Golden Jubilee Mine. is near Carrville, and is owned by D. V. Saeltzer, Redding. The cyanide plant has been remodeled, and has recently been reported in operation.

La Grange Mine has not been operated as a mine recently; but the California State Division of Highways is using water from East and West Weaver Creeks through a 30-inch line to hydraulic a cut for the highway. They expect to move 6,000,000 cubic yards. A start was made last season, and the recent rains have furnished enough water for another start this season. No attempt is being made to save gold.

Madrona Dredge near Junction City is owned by Miss Mary Smith, Lewiston. A sale to Harvey Sorensen, Secretary, United Grocers Association, 5809 Ivanhoe Road, Oakland, is reported. Some drilling has been done; and it is reported that a contract has been let for remodeling the dredge.

Northern California Mines Company, W. C. Van Antwerp, 156 Montgomery St., San Francisco, controls a strip of land about two miles long and three-quarters of a mile wide across the Trinity River from Junction City. A new suspension bridge has been built to carry a 34-inch line and a 28-inch line across the Trinity River with water at two different pressures for working pits at different elevations. The high-pressure line carries water purchased from the Pacific Gas and Electric Co. and formerly used to operate their hydroelectric plant. A water right for the other line is owned by the mining company. The mine is ready to operate during the present water season. It is expected that a total of 7500 cubic yards of gold-bearing gravel will be handled each 24 hours from the two pits. Bert Gilzean of Junction City is in charge. The old Red Hills mine is included in these holdings.

Ralston Mine is an old mine high on the mountain, about a mile and a half by trail east of Dedrick. It is now held by F. C. Meckel and G. W. Cordes of Junction City. A hundred feet of new drifting and a hundred feet of raising have exposed some very good gold ore in a 1½- to 2-ft. quartz vein. A contract for the sale of the property has been reported recently.

SACRAMENTO FIELD DISTRICT

C. A. Logan, Mining Engineer

Mr. C. A. Logan, District Engineer, has completed the preparation of a special report upon the Mother Lode Gold Belt of California, which is now in the printer's hands.

SAN FRANCISCO FIELD DISTRICT

C. McK. Laizure, Mining Engineer

Reports covering the mines and mineral resources of all of the counties in the San Francisco field division are now available, and field work at present is confined to investigations for special reports upon various economic minerals.

LOS ANGELES FIELD DISTRICT

W. B. TUCKER and R. J. SAMPSON, Mining Engineers

CURRENT MINING ACTIVITY IN SOUTHERN CALIFORNIA

By W. B. TUCKER, District Mining Engineer

The difference between $20.67 and $35 per ounce of gold has resulted in increased activity in gold mining operations in the southern counties of California. This revival of interest in gold mining has increased activity not only in the old established districts, but also resulted in new discoveries of importance in old and new areas. The districts that are active are Mojave, Randsburg, Havilah and Kernville in Kern County.

Important new strikes of commercial ore have been made in the desert areas of Kern, Los Angeles and San Bernardino counties, the most outstanding new developments being the discovery of high grade gold ore near Neenach, Los Angeles; Old Pete Mine near Ludlow, San Bernardino County; Silver Queen Mine in the Mojave district; and Drunkards Dream near Havilah, Kern County.

The development of the flotation process for treatment of gold ores has resulted in the reopening of a number of old properties such as the Big Blue Mine at Kernville and the Wilshire Bishop Creek Mine, near Bishop Inyo County.

The following is a brief description of mines under operation in the different counties in southern California:

INYO COUNTY

Big Horn Mine. It comprises 8 claims situated in the Beveridge mining district, on the east slope of the Inyo range of mountains. Elevation 6000 ft. The property is reached by trail eight miles in length from Long John Canyon over the mountain range to Hunter Canyon. Owners, Sam R. Spear and M. A. Wilson of Lone Pine. The property was discovered in 1877 by W. L. Hunter. In 1878 three arrastres, steam-driven, for treatment of high-grade ore from the mine were constructed. Capacity of arrastres was three tons per 24 hours. Hunter operated the property until 1893 and in 1900 Frederic Spear and Sam Spear purchased the property which was held by assessment work to date. In 1933 Sam Spear resumed development work on the property and has been making shipments of high-grade ore to the smelter at Midvale, Utah. Four parallel veins occur in granite. Strike N. 80° E., dip 30° to 40° N. Width of quartz veins is 2 to 8 ft.

Developments: Incline shaft 380 ft. with drifts on 100, 200, and 300-ft. levels; also two tunnels. Lower tunnel driven west 200 ft. on the vein and upper tunnel driven west 650 ft. Twenty-four tons of ore mined and shipped from high-grade orebody developed in upper tunnel, assay value of 4.68 ounces in gold and 16.60 ounces in silver or $155.35 per ton, with gross value of $3,728.40. Ore sorted, sacked and packed on mules to Mt. Whitney, a station on the Southern Pacific Railroad. Five men are employed.

Bull Domingo Mine (lead-silver). The property comprises 6 claims situated in Pine Mountain mining district, in the White Mountains, 36 miles northeast of Big Pine. Owner, A. T. Wilkerson of Big Pine. Under lease to James B. Ferguson and P. N. Johnson, 305 Ocean Center Building, Long Beach, California.

Orebody occurs on contact of schist and limestone. The fissure is 6 to 8 ft. wide. Ore is galena and lead carbonate, carrying 15 to 30% lead with 15 ounces of silver. Development consists of crosscut tunnel 300 ft. in length driven to intersect fissure at lower elevation. Tunnel will cut fissure at 600 ft. Forty-five men are employed.

Burro Mine in the Panamint district, 14 miles north of Ballarat, is owned and operated by *Panyo Gold Mining Co.,* of Los Angeles.

Cerro Gordo Mine (lead-silver). This famous lead-silver mine owned by the Cerro Gordo Mines Co. of San José, California, has been acquired under lease and bond by the *Silver Lead Syndicate, Inc.;* J. J. Beeson, president; Charles Trezona, secretary; Thomas L. Chapman, superintendent. Offices: 525 Security Building, Los Angeles. The property is situated in the Cerro Gordo mining district, 5 miles east of Keeler. An active development plan is under way. Six men are employed.

Gold Bug Mine, 4 miles east of Ballarat, owned and operated by Mrs. Ada Norris of Trona.

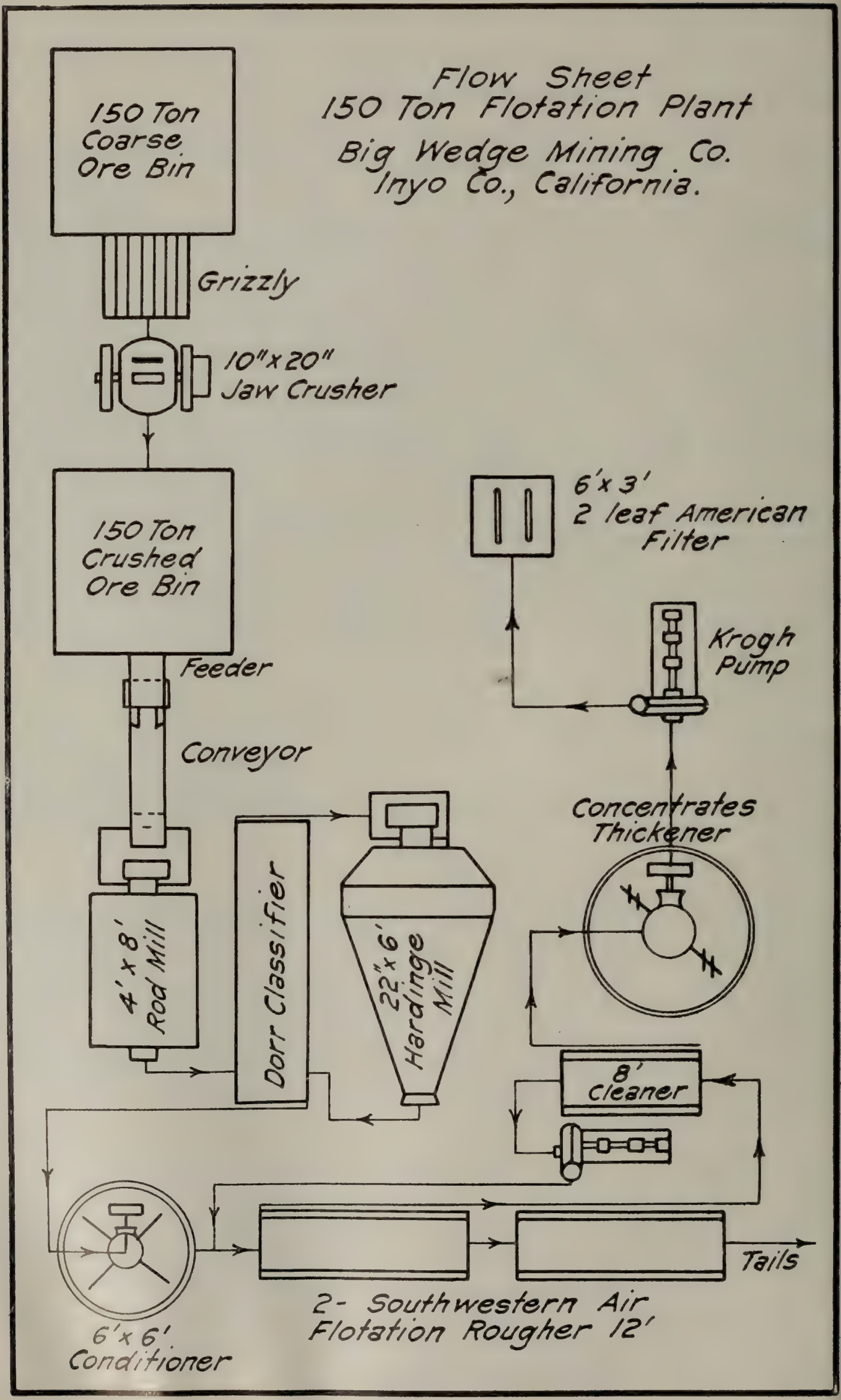
Gold Wedge Mine (gold). The property comprises 8 claims, situated in Pine Mountain mining district, 37 miles northeast of Big Pine and 1¾ miles south of Roberts Camp on Wyman Creek. Elevation 9000 ft. Owner, A. T. Wilkerson of Big Pine.

Ore occurs along joint planes in a mineralized zone in schist. Development consists of two shafts 130 ft. deep and a number of tunnels. Ore is being treated in a 5-stamp mill. Two men are employed.

Mt. Whitney-Union Mine (lead-silver and gold). The property comprises 8 claims situated in the Russ mining district, 3 miles northwest of Owenyo, a station on the Southern Pacific Railroad. Under lease and bond to *Big Wedge Mining Co.,* 408 Transamerica Building, Los Angeles; E. J. Harrison, president; N. Y. Schwartz, secretary; H. A. Pelton, superintendent.

Development consists of 5 tunnels, 4 of which are driven on the vein. Total underground development is 4000 ft. Vein has a width of 6 ft. and can be traced along its outcrop for 6000 ft. Ore is reported to carry $3 in gold, 7 ounces in silver and 3 to 6% in lead. A new flotation plant has been installed on the property with a daily capacity of 150 tons. (See flow sheet, page 312.) Sixty men are employed.

Radcliff Mine. It comprises 10 patented claims 6 miles east of Ballarat. Owner, W. D. Clair of Los Angeles. Fifty-ton cyanide plant under operation. Eight men are employed.


Flow Sheet
150 Ton Flotation Plant
Big Wedge Mining Co.
Inyo Co., California.
150 Ton Coarse Ore Bin
Grizzly
10"x20" Jaw Crusher
150 Ton Crushed Ore Bin
Feeder
Conveyor
4'x8' Rod Mill
Dorr Classifier
22"x6' Hardinge Mill
6'x3' 2 leaf American Filter
Krogh Pump
Concentrates Thickener
8' Cleaner
6'x6' Conditioner
2- Southwestern Air Flotation Rougher 12'
Tails

Wilshire-Bishop Creek Mine. The property is located in the Bishop Creek district, 26 miles southwest of Bishop, on the western slope of the Sierra Nevada Mountains, at an elevation of 8500 ft. Property consists of 12 patented mining claims, totaling 240 acres. Owner, *Cardinal Gold Mining Co.;* Bernard Smith, president; William Val De Camp, vice president and general manager. Offices: 52 Wall Street, New York City. The property was purchased by this company in the early part of 1934 from Henry Klipstein and associates.

The orebody occurs in a quartzite dike in the granite in N. 50° W. direction and dips 60° S. The dike averages about 800 ft. in width. The orebody in the dike has no well-defined walls and mineralization occurs along lines of fracturing in the quartzite, as shown by quartz stringers in the dike. The gold occurs in a very fine slate in the quartzite, associated with pyrite, a small percentage of arsenopyrite and pyrrhotite. Most of the gold is contained in the sulphides of iron. Average value per ton is $12 to $14 in gold.

Development consists of vertical shaft 300 ft. deep, with levels at 200 and 300 ft. On the 200-ft. level orebody developed for a distance of 450 ft.; on 300-ft. level for a distance of 500 ft., with crosscuts driven at different points where the principal mineralization was encountered. At 300 ft. elevation above the shaft, there is a tunnel driven N. 45° W., 400 ft. Estimated tonnage of commercial ore developed is about 200,000 tons. The company has recently completed the construction of 150-ton flotation plant. Seventy-five men are employed.

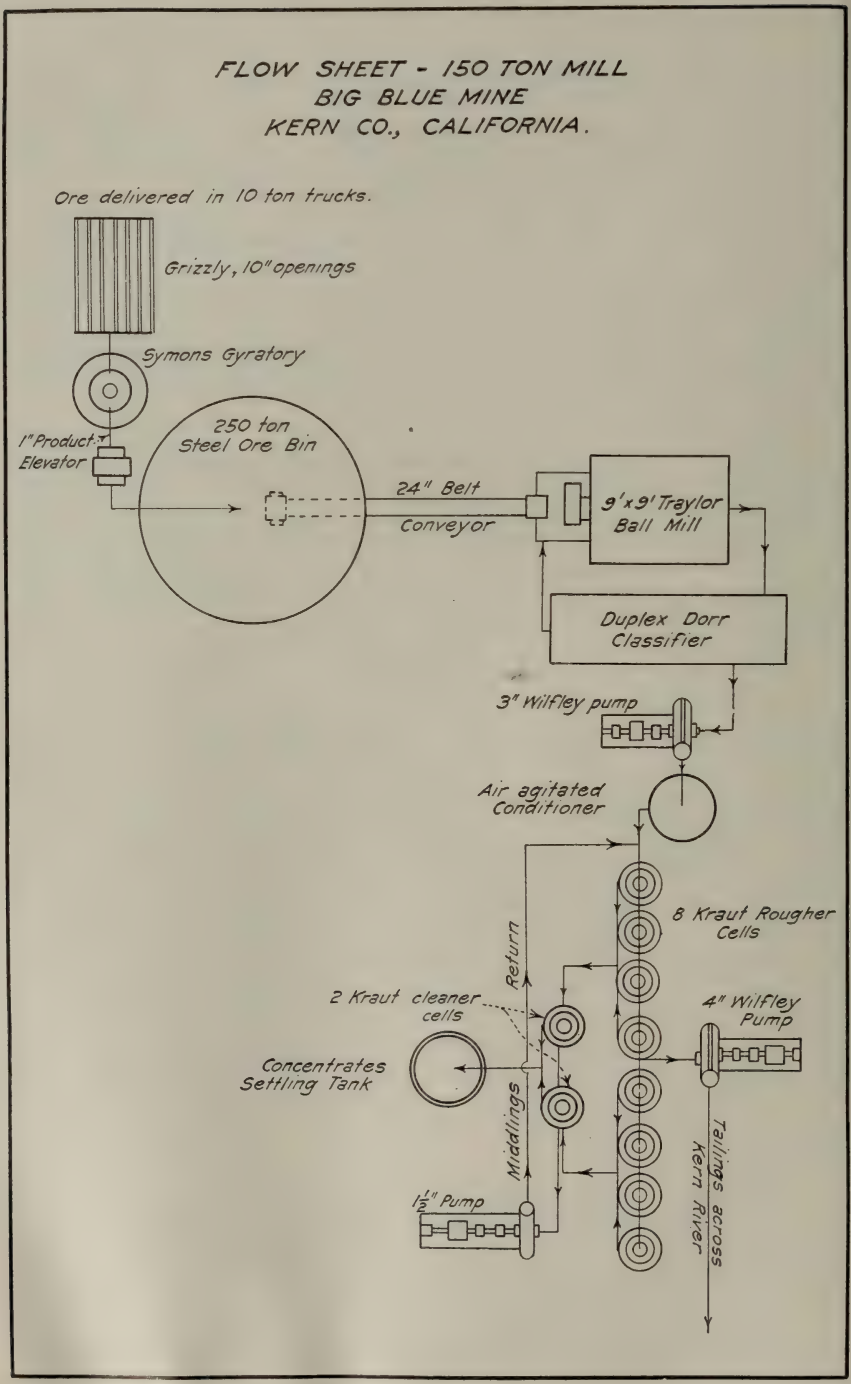
KERN COUNTY

Big Blue and Sumner Mine comprises 8 claims totaling 95 acres, situated in Cove mining district, one-half mile north of Kernville. Elevation 2900 ft. Owner, *Kern Development Co.,* Robert S. Long, manager, Kernville, California. The mine was taken under lease and bond by the *Atolia Mining Syndicate* in December, 1933. Offices: 1022 Crocker Building, San Francisco, A. V. Udell, president and general manager; R. G. McDonald, general superintendent.

The Big Blue-Sumner lode occurs on contact of granite and schist. The vein is 80 to 125 ft. in width. The vein quartz is mineralized with pyrite, arsenopyrite, galena, and sphalerite. The lode strikes N. 20° W. and dips 70° W. Development consists of 3-compartment shaft 400 ft. deep and a crosscut tunnel 3000 ft. in length, with about 5000 ft. of drifts and crosscuts. It is estimated that recent development has exposed 500,000 tons of ore with an average value of $7 per ton. The company has recently installed a 125-ton flotation plant, which will be used as a pilot mill. (See flow sheet, page 314.) A total of 50 men are employed.

Drunkards Dream Mine. It comprises 8 claims situated in Clear Creek mining district, 2½ miles east of King Solomon Mine and 4 miles from Havilah. Elevation 7000 ft. Owners, J. C. Walsher and associates of Bakersfield. This is a new discovery made in March, 1933, by J. L. Stubblefield, of Havilah.

Three parallel veins occur in granite which strike N. 70° E. and dip 60° NW.; widths vary from 2 to 4 ft. Development consists of shaft 100 ft. deep and a crosscut tunnel driven N. 40° W., 170 ft. to vein, with 200 ft. of drifting on vein. Samples taken from opencuts


FLOW SHEET - 150 TON MILL
BIG BLUE MINE
KERN CO., CALIFORNIA.
Ore delivered in 10 ton trucks.
Grizzly, 10" openings
Symons Gyratory
1" Product
Elevator
250 ton
Steel Ore Bin
24" Belt
Conveyor
9'x9' Traylor
Ball Mill
Duplex Dorr
Classifier
3" Wilfley pump
Air agitated
Conditioner
8 Kraut Rougher
Cells
Return
2 Kraut cleaner
cells
4" Wilfley
Pump
Concentrates
Settling Tank
Middlings
Tailings across
Kern River
1½" Pump

on vein also from tunnel level and shafts assayed $43 to $100 per ton in gold, with average widths of 3 ft. One hundred tons of ore milled in John Hooper's mill at Hobo Hot Springs had an average value of $75 per ton. The owners are installing a 25-ton mill for treatment of the ore. Eight men are employed.

Elephant and Gray Eagle Mines. Comprise 11 claims situated in the Mojave mining district, 5 miles south of Mojave. The property is under lease to Jess Knight of Salt Lake City, Utah. There are 15 men on the company's pay roll and about 50 men are working on individual leases on the property.

The veins on this property occur in rhyolite-porphyry and are more or less parallel, their strike being N. to N. 30° W., dip 60° to 80° E. Width of veins vary from 3 to 12 ft. The veins are typical quartz veins, containing quartz minerals derived from alteration of the wall-rock and deposited in the fissures. Pay ore occurs in well-defined shoots, about 200 ft. in length, with widths varying from 4 to 15 ft. The gold occurs, associated with pyrite, galena, marcasite and sphalerite. Silver occurs as horn silver, cerargyrite, changing to argentite in depth.

The cyanide plant has a capacity of 60 tons per 24 hours. The ore milled from the Elephant Mine averaged $15 per ton.

Gwynne and Jennette Mines. The property comprises 445 acres (patented) situated in Green Mountain mining district, in Piute Mountains, 25 miles northeast of Caliente. Elevation 7500 ft. Owners, Otto and Jack Geringer, of Chicago, Ill.

Three parallel veins occur in granite, strike east and west and dip 40° S. Width of veins varies from 12 in. to 2 ft. The vein quartz shows free gold associated with pyrite and marcasite, usually free-milling high-grade ore. Average value of ore milled runs $40 per ton. Development consists of tunnels. On Gwynne vein, tunnel is driven on vein 1750 ft.; Kersey vein, tunnel 600 ft.; Jennette vein, tunnel 700 ft.

Mill has a capacity of 25 tons, consisting of 4 ft. x 4 ft. ball mill; Senn amalgamator; Wilfley concentrator. Concentrates recovered carry $200 per ton. Eight men employed.

King Solomon, G. B. and Windy Mines. These properties are situated in the Rand Mining District, at Randsburg. Owned and operated by the *International Mining & Milling Co.,* A. G. Ilseng, president, 183 N. Martel Street, Los Angeles.

Four veins occur in schist and quartz monzonite on the King Solomon property. These vary in strike from N. 35° W. to N. 80° E., while dips vary from 40° to 50° to northeast. Width of veins vary from 12 in. to 2 ft. King Solomon shaft is 580 ft. deep on an incline of 45°. Underground development consists of 11,000 ft. of crosscuts and drifts.

The company is milling ores from the King Solomon, G. B. and Windy mines in about equal proportions, treating about 50 tons per day. Mill consists of fifteen 1000-lb. stamps, followed by plates; 4 ft. x 6 ft. Traylor ball mill in closed circuit with Dorr classifier to conditioner and 4 Groch flotation cells. Average value of ore from all sources is $9.50 per ton. Recovery 93%. Seventy-five per cent of the values are free. Total production to September 1, 1934, has been $130,000. Sixty men are employed.

The Mojave Smelting Company, Mojave, California, Wm. McNeill, 1142 Viola, Glendale, owner, is completing the construction of their 25-ton smelter and report that they expect to have it in operation by September 15th.

Ore is to be delivered in trucks to 50-ton concrete bin, 9 x 15 jaw crusher, to elevator boot. Elevated 46 ft. Elevator discharge is sampled by a Snyder sampler. From the sampler, the material goes to a 50-ton steel bunker, thence by elevator to small steel bunkers over the furnace, which is a new type invented and designed by Wm. Kekeich. The dimensions of this furnace are 14 ft. 7 in. long by 14 ft. wide and 8 ft. high, overall. The slag goes to a small settling furnace 6 ft. 6 in. square by 4 ft. 6 in. high. Gases from the furnace are conducted some 50 ft. through an underground flue and dust chamber to a stack which is 44 ft. high. The bottom 16 ft. of this stack is 6 ft. in diameter, at which point it is reduced to 2 ft. Four water sprays are used inside the stack.

Silver Queen, Mojave District, Kern County. Looking Northwest. Silver Queen Shaft and Elephant Mill

Refining furnaces, and complete assay equipment have also been provided. All machines have individual motor drives.

Six men are employed on construction.

Silver Queen Mine, consisting of 1 claim (18 acres), is situated on the west slope of Soledad Mountain, near its top, at an elevation of 3800 ft., in the Mojave mining district, 7 miles south of Mojave. This property was discovered on September 17, 1933, by George Holmes, who with his father, M. A. Holmes, now controls the property. This claim was formerly called McBrayer (see map, page 416).

The vein occurs in rhyolite porphyry, strikes N. 40° W., and dips 60° northeast. The vein varies in width from 7 to 40 ft. The vein quartz is mineralized with cerargyrite (horn silver) argentite and gold. Principal values are in gold, the ratio being about 70% gold and 30% silver. One hundred cars of ore have been shipped from the property to the Selby smelter. Returns had an average value of $30 per ton, of which $23 is gold and $7 silver, per ton. Total production to September 1, 1934, has amounted to $200,000.

Development consists of two shafts 45 ft. apart, sunk on the vein. The southeast shaft is 100 ft. deep and the northwest shaft is 200 ft. deep. Drift from 100-ft. shaft 100 ft. north and 100 ft. south. At the 200 ft. level in the northwest shaft, a drift has been driven northwest 180 ft. and a drift southeast 190 ft. All of these workings are in ore, with neither wall exposed in drifts. The ore is not sorted but shipped as broken in mining operations. Shipments amount to 50 tons per day. Propose to construct a 25-ton, all-slime cyanide plant. Thirty-five men are employed.

Later (Dec. 5) a crosscut tunnel has been driven south 140 feet to vein, with a drift southeast 150 ft. to incline shaft on the 200 ft. level, then a drift southeast 600 ft. At a point 150 ft. northwest of 200 ft. incline shaft a winze has been sunk to a depth of 180 ft. below the 200 ft. level. Width of vein as developed in winze is 6 ft. Owners state a sample cut across full width exposed in winze averaged over $30 per ton.

Tropico Mines. The property comprises 11 patented claims, 220 acres, situated five miles northwest of Rosamond. Elevation 2800 ft. Owner, Tropico Mining & Milling Co.; Clifford Burton, president and general manager.

The vein system consists of 6 parallel veins that follow fault fractures in rhyolite. These veins strike east and west, dip 60° S. and have widths varying from 6 to 12 ft.

Development consists of shafts sunk on the Home, Fairview and Lida veins. The main shaft is sunk on the Home vein to a depth of 700 ft. Average value of ore mined varies from $6 to $16 per ton. Fairview shaft is sunk to a depth of 300 feet. This claim is under lease to Henry Kelsey and Edward Myler of Rosamond. Ore is being mined from 140 and 240 ft. levels. Average value of ore mined is $15 per ton. Ore is milled by Tropico Mining & Milling Co. Ten men are employed. The cyanide plant has been increased from 30 to 50 tons per day. Ore milled comes from Tropico Mine, Mojave district and Neenach district. Twenty men are employed.

Yellow Aster Mine. Owner, Yellow Aster Mining & Milling Co.; Albert Anker, president, Randsburg, California. The property was taken over under lease and bond by the *Anglo-American Mining Corporation* during the latter part of 1933. H. W. Klipstein, president; A. W. Frolli, general manager. Offices: Mills Building, San Francisco.

Since the company acquired the property an active plan of underground development has been in progress with favorable results. A number of changes have been made in the mill with the idea of enlarging the capacity of the plant. The present plan is to screen and reject a certain portion of oversize material, the finer sizes being fed to fifty 1000-lb. stamps, followed by plate amalgamation, then followed by flotation equipment consisting of 10-cell Kraut roughers and 2 Kraut cleaners. Capacity of plant is 250 tons per day. Sixty men are employed.

LOS ANGELES COUNTY

Big Horn Mine. It consists of 15 claims, two mill sites (patented) situated on North Baldy Mountain, 28 miles east of Palmdale. Owner, Mrs. F. C. Fenner of Los Angeles. Under lease and bond to R. B. Huffman of Los Angeles.

The vein of quartz is 25 ft. wide on contact between gneiss and schist. The strike is N. 40° E. to N. 60° E., dip 20° NW. Developed by 3 tunnels at different elevations. The intermediate tunnel, 600 ft. in length, cuts the vein 400 ft. below outcrop. Lower crosscut tunnel is 1450 ft. in length. Average value is stated to be $4 per ton.

Diesel plant, compressor and 50-ton flotation plant have been installed on the property. Twenty-five men are employed.

Brite Lease on Rogers-Gentry Property, Neenach, Los Angeles County

New York Mine. Situated in the Cedar mining district, 3 miles north of Acton. Reopened and operated by J. F. Gage and McWilliams of 725 Figueroa Street, Los Angeles.

Development consists of a number of tunnels, the main working tunnel 800 ft. in length and winze 100 ft. in depth. Vein strikes N. 30° W., dip vertical; width 18 in. to 4 ft. Average value of ore mined is $30 per ton. Production to date $20,000. Ore milled in 2-stamp mill located on highway.

Rogers-Gentry Mine. It comprises 160 acres of patented land situated in E. ½ of Sec. 27, T. 8 N., R. 16 W., 4 miles southeast of Neenach, and 25 miles west of Lancaster, in a low range of hills south of Antelope Valley. Elevation 3000 ft. This important discovery of high-grade ore was made by W. J. Rogers in developing water on the land that he had purchased.

The vein occurs on contact of gneissoid granite and quartzite. Strike N. 50° W., dip 45° SW. Width of vein varies from 3 to 6 ft.

Development consists of tunnel 150 ft. in length and opencut at point of discovery to the northwest of Brite Lease and the Brite Lease one-quarter of a mile to the southeast. On Brite Lease is an incline shaft 80 ft. deep which has been stoped for a distance of 75 ft. in length to surface. Ore from Rogers-Gentry property has an average value of $50 per ton in gold, while Brite Lease ore carries about $40 per ton. Total gross production to September 1, 1934, is $80,000. Distributed as follows: Rogers-Gentry $45,000 and Brite $35,000. Ore milled at the Tropico Mining and Milling Company's plant.

MONO COUNTY

Last Chance Mine. It comprises six claims situated in the Chidago district, 13 miles southwest of Benton. Elevation 7000 ft. Owned by H. A. Van Loon of Bishop, California. A vein of quartz occurs in schist, strikes N. 70° E., dip vertical. Width varies from 6 to 12 inches.

Development: Tunnel driven southeast 100 ft. on vein which strikes northwest and southeast, and dips 38° NE., width 6 in., which intersects N. 70° E. vein. About 70 ft. NE. of intersection of 2 veins, a winze has been sunk to a depth of 75 ft. In this winze levels have been driven at 25-ft. intervals. Drifts have been driven east 150 ft. and west 100 ft. Ore shoot developed is 140 ft. in length with average width of 8 in. Three hundred tons of ore shipped from the property to the smelter at Midvale, Utah, had an average value of 1.85 oz. per ton in gold. Equipment consists of Ingersoll-Rand air compressor with capacity of 110 cu. ft., Sullivan air turbine hoist. Three men are employed.

Log Cabin and Sunrise Group of Mines. This property consists of 17 claims, situated in Mono Lake mining district, 2½ miles west of Mono Lake, P. O. Elevation 9600 ft. Owner: J. R. Simpson of Los Angeles. Acquired in 1933 by *Mutual Gold Corporation,* Spokane, Wash.; R. F. Collins, president; B. L. Collins, secretary.

Property has been under active development during the past year. Development consists of shaft 175 ft. deep and a number of tunnels. They propose to drive a lower tunnel to connect with shaft. Ten-stamp mill has been installed on property. Ore is said to average $15 per ton in gold. Ten men employed.

Lone Star Mine (lead-silver and gold). It comprises 7 claims, situated in the Chidago district, 12 miles southwest of Benton. Elevation 7100 ft. The property was formerly owned and operated by Lone Star Mining Company of Reno, Nevada; now owned and operated by H. A. Van Loon of Bishop, California. The vein strikes N. 15° W., and dips 80° W. in rhyolite. Width of vein varies from 18 in. to 3 ft. Vein quartz is mineralized with pyrite, galena, marcasite, carrying values in gold and silver.

Since the writing of Report XXIII of the State Mineralogist, pp. 396 and 397, a new shaft was sunk 200 ft. east of the old shaft to a vertical depth of 475 ft., with levels at 150, 250, 300 and 400 ft. Sixty-two tons of ore, shipped from the dump recently, had an average value of $12 per ton in gold, with 26 oz. in silver and 17% lead. Two men employed on development.

Mammoth Consolidated Mines. Property consists of 19 claims, situated on the west slope of the Sierra Nevada range of mountains, 6 miles southwest of Mammoth Lakes, P. O. Elevation 9000 ft. Owner, Mammoth Consolidated Mines Co.; Lewis Cox, president; A. J. Mahan, secretary, 1240 Subway Terminal Building, Los Angeles; C. R. Johnson, superintendent.

The principal rocks of this area are dioritic porphyry and belts of crystalline rocks to the north and south of Mammoth Creek. The top of the ridge is capped with andesite. The mineralization is principally confined to a belt of crystalline rocks which is about 500 ft. wide and has a general northwest course. Vein strikes NW. and SE., dips 85° SW. Width varies from 9 to 30 ft.; average width 15 ft. Vein material is mineralized with magnetite, oxides of iron, auriferous pyrite, chalcopyrite, sphalerite and native gold. Grade of ore $9 to $15 per ton.

Development consists of 2 tunnels, upper tunnel 85 ft. in elevation above lower tunnel. Upper tunnel 240 ft. in length, lower tunnel 500 ft. in length. Property equipped with Diesel plant, compressors, and 50-ton concentration plant. Six men are employed. They expect to resume operations at an early date.

Standard Consolidated Mines, Bodie, California. This property is owned by J. S. Cain of Bodie. A number of leasers are extracting ore from workings on Standard Mine. Ore milled in Standard Mill. Twenty to thirty men are employed.

Tioga Mine. It comprises a group of 6 patented claims, located on what is known as the Sheepherder and Great Sierra Lodes, in the Tioga mining district, 12 miles west of Lee-Vining, a town on the Bishop-Bridgeport highway. Elevation 10,000 ft. Owner, Antoinette S. Swift; under option to Tioga Mining Company of New York City; Hulbert A. Yerkes, president; W. R. Palmer, superintendent.

The property was located in 1878 and operated by the Great Sierra Mining Company from 1882 to 1884. This company drove a crosscut tunnel 1800 ft. in length to intersect Sheepherder lode. It is stated that from 200 to 300 ft. will have to be driven to cut the lode. The lodes occur in siliceous and graphitic slates, in contact with quartzite and gneissoid granite. The Tioga lodes are 6 to 40 feet in width, strike N. 30° W., dip 70° W. The vein material of the Tioga lodes is a white, crystalline quartz, and the ores argentiferous and auriferous mixtures of pyrite, chalcopyrite, sphalerite, with marcasite, arsenopyrite and galena. Values in gold are $8 to $15 per ton. The tunnel will cut the Sierra and Sheepherder lodes at a depth of 1000 ft. below their outcrops. Twenty men are employed on development work.

RIVERSIDE COUNTY

Alice Mine. It consists of 6 patented claims situated 6 miles south of Vidal. Recently purchased by the *Reliance Consolidated Mines Co.;* E. P. Warner, president; George Krieg, secretary; P. M. Warner, general manager, Los Angeles.

Vein strikes northwest and southeast, occurs on contact of schist and granite; width 4 ft. Ore is oxidized gold and copper ore. Average value $15 per ton in gold. High-grade ore shipments have value of

$50 per ton in gold. Company has installed 50-ton Marcy ball mill and concentration plant. Twelve men are employed.

Brooklyn and Los Angeles Mines. The property comprises 15 claims situated in Dale mining district, 45 miles northeast of Mecca, and 30 miles south of Amboy. Owner, *Campbell Gold Mining Co.* Under lease to W. H. Butler, of Los Angeles.

Two parallel veins occur in granodiorite, known as Brooklyn and Los Angeles, which are about 1000 ft. apart. Veins strike northwest and southeast, dip 70° NE. Widths of veins vary from 2 to 6 ft. Brooklyn vein is developed by a tunnel 550 ft. in length, with winze 200 ft. deep. Los Angeles vein is developed by a shaft 750 ft. deep, with 5000 ft. of underground workings. Mill comprises three 1250-lb. stamps, plates and 25-ton cyanide plant. Present operations are confined to treating 5000 tons of tailings said to average $8 per ton in gold. Eight men are employed.

Calzona Mines. Holdings comprise 12 claims, in the Bendigo mining district, 6 miles southeast of Vidal. Owner, Calzona Mines Co. of Los Angeles; B. M. Stansbury, president; H. E. Olund, general manager, 1130 Citizens National Bank Bldg., Los Angeles.

The vein occurs on contact of schist and limestone. The ore is oxidized gold and copper ore.

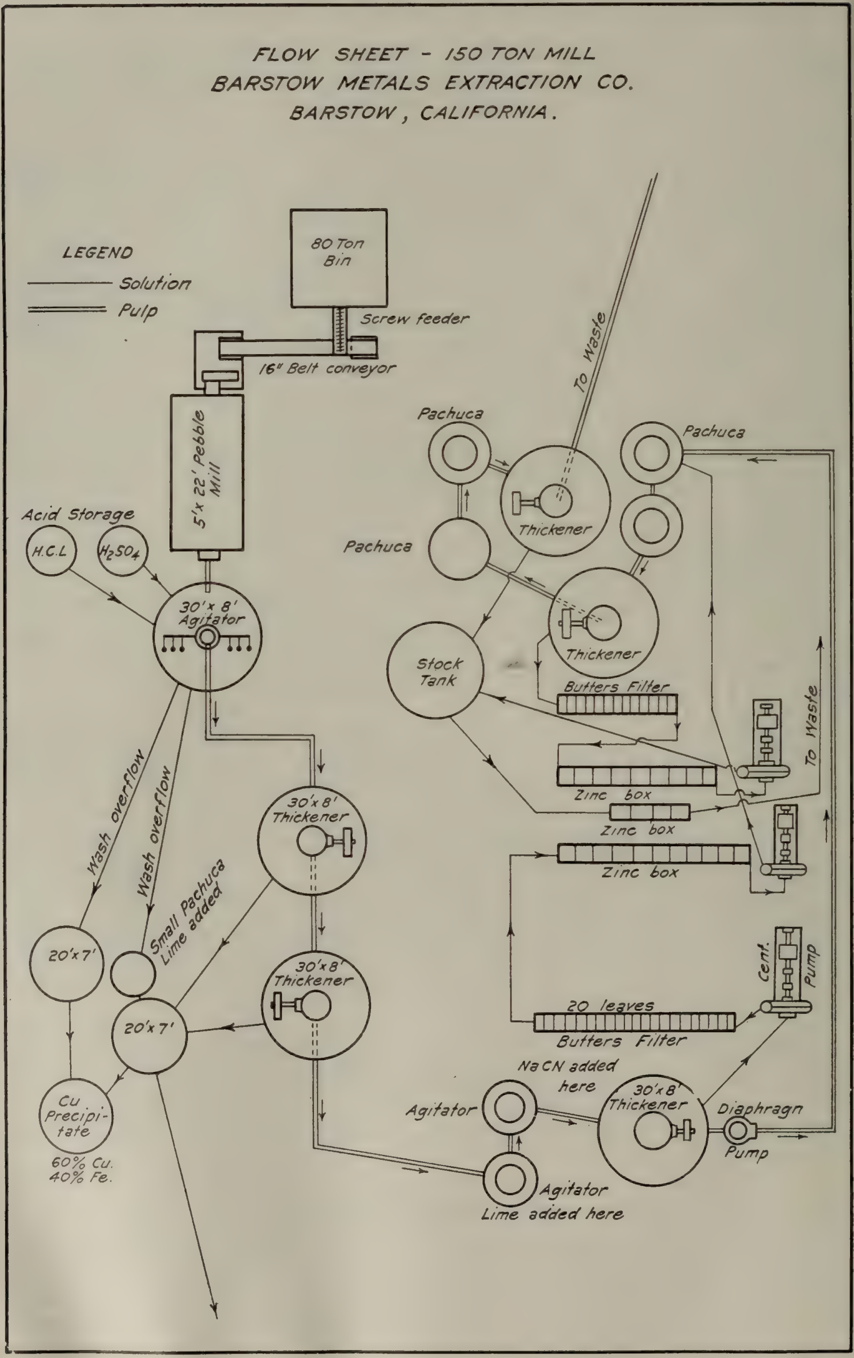
Development consists of tunnel 600 ft. long and 200-ft. shaft, with 5000 ft. of drifts and crosscuts. They are installing Diesel plant and compressor. Twelve men are employed on construction and development work. Company plans to install flotation plant for treatment of ore.

Gavilan Mines. These mines are located 6 miles west of Perris, on the Rancho Sobrante de San Jacinto, in the Pinacate mining district. Under lease to *Ida Leona Mines Co.;* H. L. Nelson of Riverside; R. A. Bates, manager.

Two parallel quartz veins occur in granite. Strike northwest and southeast, dip 40 to 60° W.; width 8 in. to 2 ft. Development consists of Gavilan incline shaft 485 ft. deep. Sinking new 2-compartment shaft to proposed depth of 300 ft. Equipment consists of 15-h.p. Fairbanks-Morse hoist; 300 cu. ft. C. P. compressor; 4 ft. x 5 ft. Marcy mill; Simplex-Dorr classifier, plates, and Wilfley concentrator. Fifteen men are employed.

Gold Crown Mine. Property comprises 25 claims, situated in Dale mining district, 20 miles southeast of 29 Palms. Elevation 2000 ft. Owner, Gold Crown Mining Co.; George Novell, president and general manager; O. J. Marston, secretary. Offices, 730 Petroleum Securities Building, Los Angeles.

Three parallel veins occur in granite, strike N. 20° W., dip 75° W.; widths vary from 2 to 4 ft. Developed by shafts 100 to 600 ft. deep; main shaft 600 ft. deep, with levels at 200, 300, 450 and 600 ft. Mine equipment consists of 25-h.p. hoist and 9-in x 8-in. Ingersoll-Rand compressor, driven by 150-h.p. Marine gas engine. Installing diesel engine and 50-ton cyanide plant. Also installing 4-inch pipe line from company's well at Old Dale, a distance of 9 miles. Twenty men are employed.



FLOW SHEET - 150 TON MILL
BARSTOW METALS EXTRACTION CO.
BARSTOW, CALIFORNIA.

LEGEND
Solution
Pulp
80 Ton Bin
Screw feeder
16" Belt conveyor
5'x 22' Pebble Mill
Acid Storage
H.C.L
H_2SO_4
30'x 8' Agitator
Wash overflow
Wash overflow
Small Pachuca Lime added
30'x 8' Thickener
30'x 8' Thickener
20'x 7'
20'x 7'
Cu Precipi-tate
60% Cu.
40% Fe.
To Waste
Pachuca
Pachuca
Pachuca
Thickener
Thickener
Stock Tank
Butters Filter
Zinc box
Zinc box
Zinc box
To Waste
Cent. Pump
20 leaves
Butters Filter
NaCN added here
Agitator
30'x 8' Thickener
Diaphragm Pump
Agitator
Lime added here

Good Hope Mine. Situated 4½ miles southwest of Perris, in Pinacate mining district. Under lease and bond to James M. Hyde of Los Angeles; W. H. Smith, superintendent.

Installed 50-ton Marcy ball mill in closed circuit with Duplex Dorr classifier followed by amalgamation plates and flotation machines. The present operations are confined to treating dump material. Six men are employed.

SAN BERNARDINO COUNTY

Atolia Rand Placers, Inc., C. H. Morris, president and manager, Chester Williams Building, Los Angeles.

Property consists of 600 acres situated 1 mile southwest of Atolia, San Bernardino. Estimated yardage of proved gravel is 1,800,000 yards, with an average value of 75 cents per yard in gold. In the latter part of 1933, a mechanical screening and concentration plant was installed on the property having a capacity of 100 tons per day. Water is secured from Cuddeback Lake, through 4-inch pipe line, 7 miles in length. Recoveries made in the mill are as follows: Gold 73 cents, tungsten concentrate (Scheelite) 60 cents; total value of $1.33 with 59 cents in tailings. Eight men are employed.

Barstow Metals Extraction Company, Elliott Sparling, president; S. D. Greenwood, secretary. Office, Bradbury Building, Los Angeles.

During the latter part of 1933 this company acquired a lease on the tailings dump, located 1 mile west of Barstow. The tailings dumps are said to contain 75,000 tons, with an assay value of 0.155 oz. in gold, 0.93 oz. in silver, and 0.70% in copper. The tailings are the result of ore milled by the Bagdad-Chase Mining Company from the Bagdad-Chase-Roosevelt Mines, located near Ludlow. The Bagdad-Chase Mining Company operated the mill from 1904 to 1910, and is reported to have milled 100,000 to 150,000 tons of ore.

Due to the presence of copper carbonates and copper silicates in the tailings, attempts made to treat the tailings by cyanidation have proved unsuccessful because of the large amount of cyanide required when copper is present in the ore. Mill tests made on tailings by Ed. Eisenhauer of 224 South Spring Street, Los Angeles, led to the development of leaching process for elimination and recovery of copper before treatment by the cyanide process.

Eisenhauer Process: Unground pulp thickened with water until showed 60% solid content; then 2.20% equivalent of H_2SO_4 was added, and contact with agitation was continued one hour. At the end of this period 0.60% of H.Cl. by weight was added and agitated for 12 hours. Then the pulp was washed with water twice and the tailings showed the following assay in copper, 0.017%. The acidity of the tailings was then neutralized by adding 10 lb. of lime and they were ground in cyanide solution to 80 mesh; air agitation for 12 to 24 hours. For 24 hour contact showed gold, .01 oz., or $0.35; silver, 0.29 oz., $0.12—indicated extraction of 93.9% of the gold and 66.7% of silver.

Based on these tests, the company installed 100-ton leaching and cyanide plant. (See flow sheet, page 322.) The plant at present is idle due to mechanical troubles encountered during operations, and it is stated that, with the installation of special Dorr mechanical equipment for agitators, operations will be resumed.

Desert King Mine. It comprises 640 acres in Sec. 16, T. 10 N., R. 1 W., S. B. M., situated 6 miles northeast of Barstow. Elevation 2600 ft. Owner, *Sacramento Land and Development Company,* Forum Building, Sacramento. A subsidiary company has been organized by the members of the above corporation, known as the Desert King Mining Company, Frank Newbert, president, Forum Building, Sacramento.

A mineralized zone, 500 to 600 ft. in width, occurs in pre-cambrian schist and gneiss. The strike of this zone is northeast and southwest, dip 40° NW. Developments: During the early part of 1934, this company put a gas shovel on the property and cut 10 trenches in the mineralized zone. The trenches are 100 to 400 ft. in length with depth of 2 ft. Samples were cut in 5-ft. segments. Assays of samples show values ranging from 70 cents to $2.40 in gold. On the northeast end of the property the development consists of open-cut 30 ft. in length and 15 ft. in depth, also tunnel driven southwest 56 ft. At present they are sinking a vertical shaft to a depth of 50 ft., about 50 ft. south of the tunnel. Four men are employed.

Fremont Peak Mine. It comprises 28 claims situated on the western slope of Fremont Peak, in Secs. 33 and 34, T. 31 S., R. 42 E., S. B. M., 18 miles southeast of Randsburg. Elevation 3800 ft. Owner, *Monarch Rand Mining Company:* W. O. Walker, president; Fred P. Rossiter, secretary, 222 S. Thomas Street, Pomona, California.

A series of parallel veins occur in granite and also on contact of rhyolite porphry dikes and granite. Veins strike northeast and southwest, dip 70° north. Widths vary from 12 in. to 4 ft.

Developments consist of incline sunk on the vein to a depth of 185 ft.; on the 50-ft. level, drift northeast 275 ft.; on the 100-ft. level, drift northeast 300 ft.; on the 185-ft. level, drift 300 ft. southwest, and drift northeast 1100 ft. At 120 ft. west of the shaft a crosscut has been driven northwest 1280 ft., cutting five parallel veins which strike northeast and southwest. Ore-shoot, developed on the 185-ft. level, is 400 ft. in length with an average width of 2 ft. The average value is said to be $20 per ton in gold. The vein quartz shows gold, mineralized with pyrite and arsenopyrite.

Power plant: 125-h.p. Fairbanks-Morse diesel engine directly connected to 90-k.v.a. generator. The mine equipment consists of 30-h.p. electric hoist (12″ x 14″) (7″ x 10″), Ingersoll-Rand compressor driven by 50-h.p. motor. Mill equipment: 75-ton coarse-ore bin. Ore from the coarse-ore bin is fed to a 12 in. x 20 in. Wheeling crusher, driven by a 15-h.p. motor; crushed to $\frac{3}{4}$ in. size; from the crusher to the fine-ore bin, capacity 75 tons, fed by Challenge ore feeders, to six 1250-lb. Nisson stamps. Each battery of 3-Nisson stamps is driven by a 15-h.p. motor. The ore is crushed to 40-mesh, then pulp to 5 ft. x 10 ft. amalgamation plates, and flows to a Wilfley table, driven by a 5-h.p. motor. Recovery made by amalgamation and concentration was only 60%. Therefore, operations were suspended. The company plans to install a cyanide plant for treatment of the ore. Water supply is secured from a well 229 ft. deep on a small dry lake 2 miles due north of the mine. A Byron-Jackson hydro-pressure pump pumps the water through 11,000 ft. 2½ in. pipeline to a storage tank at the mine. The lift is 1000 ft. The capacity of the pump is 50 gal. per minute. Idle.

Kelly Gold and Silver Mines, Inc., Frank Royer, vice president and general manager, Hollingsworth Building, Los Angeles. This company purchased the California Rand Silver in the early part of 1933.

This property was the largest single producer of silver in the United States until 1930. The property comprises 70 claims situated 1½ miles southeast of Randsburg, Kern County. Developed by a vertical shaft to a depth of 1442 ft. The property has been under steady operation to date by the present company. During this period 51,000 tons of ore has been milled from which there has been recovered $304,050 or an average value of $5.95 per ton. The flotation plant has been handling 175 tons of ore per 24 hours. There is fully developed between the tenth and twelfth levels 75,000 tons of ore, varying from $6.50 to $11 per ton. Width of ore mined varies for 8 to 15 ft. The company employs 75 men.

Vanderbilt Mines. It comprises 18 patented claims, situated in the Vanderbilt district, 4 miles east of Ivanpah. Owner, Allen G. Campbell Estate, Beverly Hills, California. Under lease and bond to the *Atascadero Mining Co.;* Oscar L. Willett, president, 824 W. N. Garland Building, Los Angeles; J. E. Chilberg, superintendent.

A series of parallel veins occur in the granite, strike N. 70° W., dip 60° N. Average width of veins is 8 ft.; average value $15 per ton. Gold Bar lode is developed by three shafts, main working shaft being the Gold Bar 425 ft. deep, sunk on the vein.

The company has installed a 25-ton flotation plant and is shipping concentrates to the American Smelting & Refining Company's smelter at Garfield, Utah. During 1934 they shipped 18 cars of ore to the smelter at Midvale, Utah; an average value of $25 per ton. They also propose to sink a new vertical shaft to a depth of 500 ft. Twenty men are employed.

War Eagle Mine (lead-silver). It comprises 9 claims situated in Bullion Mountains, 9 miles south of Bagdad, a station on the Santa Fe Railroad. Owner, L. W. Osborne, 237 S. Hancock Street, Los Angeles.

The ore deposits occur in a well-defined fault fracture in rhyolite porphyry, striking N. 60° W., and dipping 40° SW. The hanging wall of the fault is a brecciated tuft. The ores found along the fissure are chlorides and chloro-bromides of silver, with galena, lead carbonates and some wulfenite (molybdate of lead) and vanadinite (vanadate of lead). Ore on dumps is being worked by L. W. Osborne and L. W. Y. Carsten, of Long Beach. The dump ore is hauled by trucks to a concentration plant on Bristol Lake, with a capacity of 40 tons per 8 hrs. Jiggs are used in the plant, producing a concentrate assaying 40% lead, 30 oz. silver, $2 per ton, gold. The concentrates also carry 4 to 6% V_2O_5 and 10 to 12% MoS_2. They are shipped to the International Smelting Company, Salt Lake City, Utah. Six men are employed.

Yim-Wheelock Mine (Old Pete Mine). It is situated in the Buckeye mining district, 4 miles south of Ludlow. The property consists of 3 claims, totaling 60 acres. Owners, Lee Yim and William Wheelock of Ludlow, California. The discovery of high grade ore in quantity by William Wheelock in December, 1932, caused a great amount of interest and excitement.

The ore occurs in a brecciated dacite-porphyry. The cementing material is quartz and hematite. In places the entire mass is white, granular quartz, carrying free gold. The strike of the mineralized zone is north and south with dip of 30° to the east. As at present exposed in an opencut, the ore is 50 ft. wide and about 500 ft. in length. Average grade of ore shipped was 0.81 oz. ($16.20) per ton in gold. Gross production to date, $21,500.

Yim-Wheelock Mine, 4 Miles South of Ludlow, San Bernardino County

SAN DIEGO COUNTY

Eagle Mine comprises one patented claim situated one mile east of Julian in the Julian mining district. Elevation 4200 ft. Owner, A. P. Frary, Julian, California. Under lease to Sidney B. Dodge and associates, of Julian.

Developments consist of two tunnels 300 ft. in length and shaft 100 ft. deep. A 5-stamp mill has been installed on the property. Since March, 1934, $800 worth of gold has been shipped to the mint. The mill is also operated as a custom plant.

Six men are employed.

Mesa Grande Mine comprises 6 claims situated near Mesa Grande. Owner, Milton Edgar, Los Angeles. Frank Johnson is superintendent.

A vein 2 to 8 in. in width occurs in granite; strike NW. and SE.; dip vertical. Shaft is 100 ft. deep. Ore is reported to carry from $20 to $100 in gold per ton.

Six men are employed.

Montezuma Mine comprises 6 claims situated in the Rice mining district, 12 miles southeast of Warner's Hot Springs and 6 miles north of Julian. Owner, R. J. Stanch, Inglewood, California. Under lease and bond to *Economy Mining and Milling Corporation;* Frank L. Buchanan, president and manager, 5700 Santa Fe Avenue, Los Angeles.

They propose to install Buchanan mill, capacity of 25 tons per 24 hours.

Six men are reported to be employed.

Pride of West Mine comprises one patented claim situated west of Julian in the Julian mining district. Owner, Fred Sawday, Julian, California. Under lease to P. Lomax, of Julian.

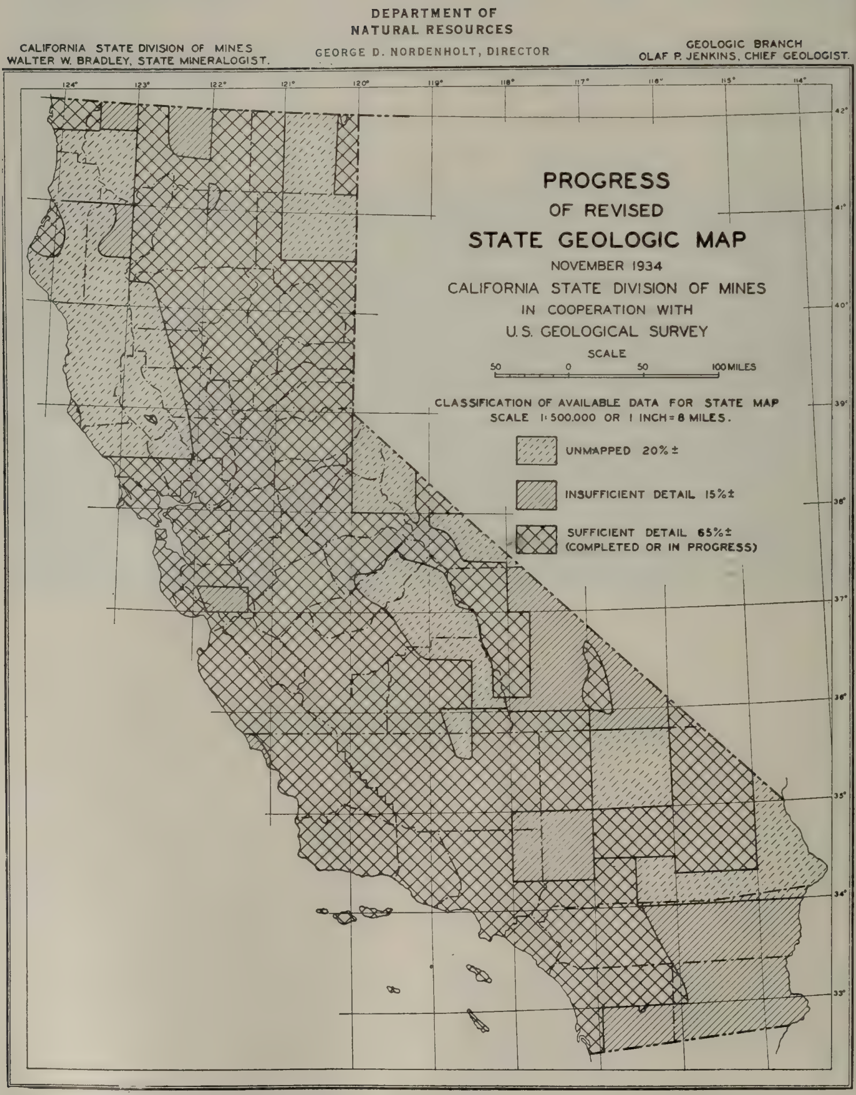
Development consists of tunnel 325 ft. in length. Ore mined is hauled to Eagle mill for treatment. Last mill run produced $400 worth of gold.

Four men are employed.

Ready Relief and North Hubbard Mines comprise 10 claims situated in the Julian mining district, three miles southeast of Julian. Elevation 2700 ft. Owners, Mary A. Baily, Julian, California, and G. W. Hazzard, San Diego, California. Under lease to E. P. Barclay, of Julian.

Ore is being mined from North Hubbard claim. The mill is treating 5 tons per day.

Ten men are employed.


DEPARTMENT OF
NATURAL RESOURCES
CALIFORNIA STATE DIVISION OF MINES
WALTER W. BRADLEY, STATE MINERALOGIST.
GEORGE D. NORDENHOLT, DIRECTOR
GEOLOGIC BRANCH
OLAF P. JENKINS, CHIEF GEOLOGIST.
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IN COOPERATION WITH
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100 MILES
CLASSIFICATION OF AVAILABLE DATA FOR STATE MAP
SCALE 1:500.000 OR 1 INCH = 8 MILES.
UNMAPPED 20% ±
INSUFFICIENT DETAIL 15% ±
SUFFICIENT DETAIL 65% ±
(COMPLETED OR IN PROGRESS)

FIG. 1.

GEOLOGIC BRANCH

CURRENT NOTES

By Olaf P. Jenkins, Chief Geologist

Three reports on geology appear in this October issue of the California Journal of Mines and Geology:

1. Geology and Mineral Deposits of the Julian District, San Diego County, California, by Maurice Donnelly. A small part of the field expenses were paid by the California State Division of Mines and the San Diego Board of Supervisors, cooperating. The rest of the expenses and time were contributed by the author as a research problem for an advanced degree conferred by the California Institute of Technology.

2. Geology and Mineral Resources of the Elizabeth Lake Quadrangle, California, by Edward C. Simpson. The field expenses for this work, which covers part of Kern, Los Angeles and San Bernardino counties, were supplied by the California State Division of Mines, the report representing a résumé of a thesis submitted as a requirement for an advanced degree of the University of California.

3. Geologic Features of the Dry Placers of the Northern Mojave Desert, by Carlton D. Hulin. This paper represents a progress report describing some of the interesting results so far obtained in the author's study of the geology of the Searles Lake quadrangle, which he is carefully mapping.

As soon as there are sufficient funds for publication, another geologic report will be issued, entitled, "Geological Investigation of the Clays of Riverside and Orange Counties, California," by J. Clark Sutherland.

The preparation of the State geologic map is steadily advancing, with funds supplied by the Federal Public Works Administration, dispensed by the United States Geological Survey; the compilation and drafting will continue until June, 1935. The work is under the direction of the Chief Geologist of the Division of Mines.

The accompanying Figure 1 shows the following simple threefold classification of the material available for the State geologic map: (1) Unmapped areas or those in which geologic data are practically missing. (2) Areas which are covered by maps with insufficient data to make a well-balanced geologic map. (3) Areas which are covered by geologic maps of sufficient accuracy and detail for the present purposes of compilation. Roughly speaking the percentages of these three classes are 20%, 15% and 65%, respectively. New information is secured, from day to day, however, so that the map serves as a place to accumulate and coordinate the data as received.

GEOLOGY AND MINERAL DEPOSITS OF THE JULIAN DISTRICT, SAN DIEGO COUNTY, CALIFORNIA *

By MAURICE DONNELLY **

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* Report submitted as part of a doctor's thesis to the Balch Graduate School of Geological Sciences, California Institute of Technology.

** Teaching Fellow in Geology, Balch School of Geological Sciences, California Institute of Technology.

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ABSTRACT

The Julian region, in the central part of San Diego County, California, includes the Julian, Banner, several other less important mining districts, and the Stonewall Mine on the Cuyamaca land grant. In addition to being one of the few areas in the Peninsular Range of southern and Baja California that have yielded notable amounts of gold, it constitutes geologically a diagnostic part of the range because of the land forms, structures, and rock formations exposed. Discovered in 1870, the Julian and Banner districts produced in the next several years $2,500,000 in gold from oxidized ore, having an average tenor of $50 a ton. This came from narrow veins which were only in a few instances mined below the water-table. The Stonewall Mine, worked continually from 1870 until shut down in 1893, produced $2,000,000 from a large orebody extracted to a depth of 600 feet. The Julian and Banner districts had a brief mining revival during the '90s.

The oldest rocks recognized are meta-sedimentary mica schist and quartzite of Juratrias(?) age. These are invaded on a batholithic scale by plutonic rocks that have an average composition of quartz diorite; in the terrane included in this survey, assimilation of material from the schist has rendered the batholith predominantly granodioritic. Near the contacts with schist masses, the granodiorite is closely foliated and this structure has probably been inherited from injected and incompletely assimilated schist. A coarse-grained granite intrudes the schist and an irregularly shaped body of fine-grained gabbro intrudes both schist and granodiorite. The granite was injected with considerable vigor; the gabbro was passively emplaced. All of the crystalline rocks have external or internal structures that trend northwest, parallel to the main alignment of the Peninsular Range.

The Juratrias (?) sediments were initially fine-grained marine shales, argillaceous sandstones, and pure sandstones. During load-metamorphism, excellent fissility was developed in the argillaceous members. Regional metamorphism prior to the intrusion of the quartz diorite produced in the sediments a schistosity parallel to the stratification. As a consequence of heat, given off by the invading batholith, a secondary foliation controlled by poorly defined fracture cleavage was produced in parts of the schist. The schist exhibits other contact and thermal metamorphic effects of the intrusion of the granodiorite. The gabbro and granite on the other hand, have had little contact metamorphic effect on the schist or granodiorite.

Almost all of the gold-bearing quartz deposits are in schist, and with the exception of the Stonewall Mine occurrence, practically all of the deposits are inclosed wholly or partly in a single body of schist which extends continuously for a distance of twelve miles and has an

average breadth of a mile. This schistose mass is the eastern limb of a northwest-plunging anticline, in which the schistosity (which coincides with the stratification) strikes northwest and dips steeply northeast, except where superficially bent upon east-facing slopes of strong relief. According to their shape, the vein-quartz bodies are classified as lenses, lenticular veins, and rolls. Lenses and lenticular veins are generally conformable to the attitude of the schist. The singular structures known as rolls are U-shaped bodies of vein quartz in which the sides of the ''U'' roughly conform to the schistosity and the curved part cuts across it. The roll structures represent deposition of quartz along directions of least resistance, partly conforming to and partly transecting the schistosity. The directions of least resistance were developed during regional folding and are related to minor or drag-folding with which they are associated. Although the rolls simulate folded veins they have not been formed by the folding of initially tabular veins.

The quartz bodies are usually 'frozen' tight to the schist country rock and well-defined fissures or gouge-walls are in the main absent. Stringers and thin layers of schist or *septa* are common in the quartz and form the typical banded or ribbon-ore of the Julian-Banner district. The deposits are high-temperature in type, corresponding to the hypothermal class of Lindgren. The paragenesis is quartz (predominant gangue), tourmaline, mica, pyrite, pyrrhotite, arsenopyrite, gold, and petzite. There is no evidence of secondary solution and redeposition of the gold. The differences in the purity of the native gold in various parts of the region may be accounted for by enrichment due to removal of part of the silver content by supergene leaching or to a closer position of some of the deposits to the magmatic source. This magmatic source is related to the batholithic intrusion of quartz diorite.

Physiographically, most of the area is an erosional surface of low relief, an uplifted peneplain, with many monadnocks, some of which possess elevations exceeding 5800 feet and relief in excess of a thousand feet. Cuyamaca Peak, loftiest of these monadnocks and the highest summit in San Diego County, owes its eminence—in common with the related Middle and North Peaks—to the underlying chonolithic mass of gabbro which, under the prevailing erosional conditions, is more resistant than the surrounding granodiorite and schist. The peneplain has been warped and broken by uplift and faulting. The general trend of the major faults is northwest and one of them, Banner fault, is a local segment of the Elsinore fault zone, a major tectonic feature of southern California. Erosion along fault zones and belts of weaker rocks has produced youthful valleys in parts of the area.

The region is readily accessible the year round to motor vehicular traffic from the coast cities of southern California. Julian, the principal town of the region, lies at the summit of the Peninsular Range in a saddle between Volcan Mountain and the Cuyamaca Peaks. This saddle together with Banner Canyon, forms a pass over the range, on one of the two direct routes from Imperial Valley to the coast of San Diego County.

The future of gold mining operations in the area will depend on the extent to which modern methods of mining and milling are applied.

INTRODUCTION

LOCATION AND TOPOGRAPHY

The name Peninsular Range has been given to the mountainous belt extending 300 miles southeast of an irregular northern boundary formed by San Gorgonio Pass and the Santa Ana River. The northern one-third of the belt is in Riverside, Orange, and San Diego counties; the remainder is in Baja California. In San Diego County, the range attains, by step-like ascents from the coastal strip, elevations exceeding 5000 feet, and, in the central east-west segment of the county, reaches a width of about 50 miles.

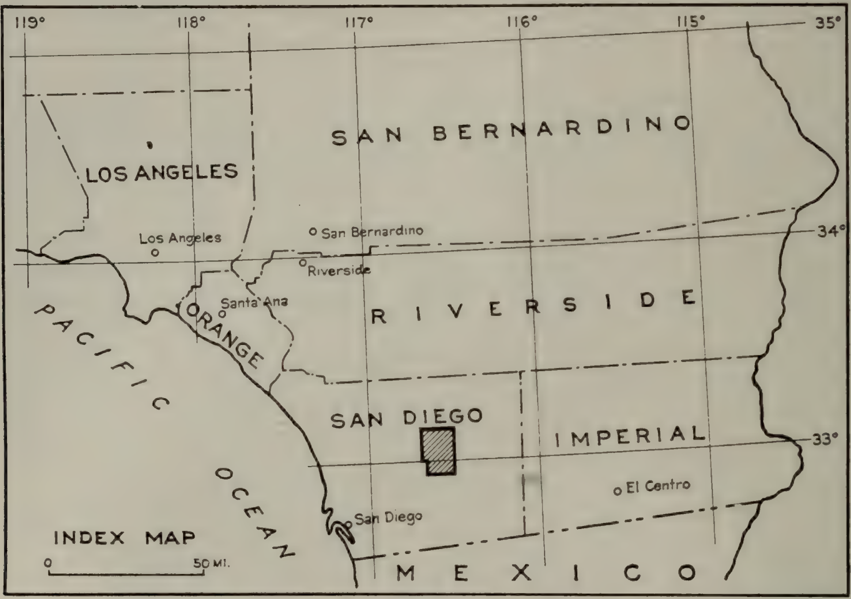

FIG. 1. Index map of southern California showing location of the area mapped in the report on the Julian district.

That part of the Peninsular Range, herein called the Julian region, lies near the geographic center of San Diego County, about 40 miles in an airline from the city of San Diego. It includes the rolling upland country—the Julian Mesa—about Cuyamaca and Julian, which lie near the crest of the Range, and the rugged area drained by Banner and Chariot creeks. The boundary between these two topographic entities is an east-facing scarp, in places remarkably steep. The relief on the Julian Mesa is commonly a few hundred feet, exceptionally, as in the case of the Cuyamaca Peaks, over a thousand feet. Much of the upland area around Julian represents a saddle between Volcan Mountain on the north and the Cuyamaca Peaks on the south. Cuyamaca Peak, loftiest of these eminences, is noteworthy in being the highest peak (6515 feet) in San Diego County.

Several land grants are partly in or near the Julian mining district; the boundaries of the district (1881) were determined largely by three grants, San Felipe on the northwest, Cuyamaca to the south, and Santa Ysabel on the northeast. A large Indian reservation, Santa

Ysabel, lies just outside the northern boundary of the area mapped, and two small Indian reservations, Cosmit and Inaja, are a short distance southwest of the western limit of the area. Knowledge of the location of these land grants and reservations is important to those interested in prospecting for minerals in the region.

The largest town in the area is Julian (elevation 4219 feet) with a permanent population in 1932 of 150. On the Julian Mesa are many summer resorts, of which Kentwood-in-the-Pines, Pine Hills, and Whispering Pines are the most important. Power, telephone, and bus lines from San Diego terminate at Julian. The town of Banner (elevation 2717 feet), once a thriving mining and milling center of several hundred people, was partially destroyed by floods in 1916 and 1926. It is now (1932) nearly deserted. Paved highways connect Julian with San Diego and Los Angeles. An improved road runs eastward from Julian by way of Banner Canyon to the Imperial Valley. Although the road in Banner Canyon is sometimes very difficult to traverse in wet weather, it is seldom impassable to light automobiles. A radiating network of secondary and mining roads exists.

CLIMATE AND VEGETATION

In the upland valleys and ridges of the Julian Mesa the climate is temperate, the rainfall varying between 25 and 45 inches a year. Eastward and westward the rainfall diminishes, the decrease being gradual to the west, sharp and sudden to the east so that at Banner, three miles east of Julian, the rainfall is estimated to average 12 inches a year, while two miles farther east in the lower part of San Felipe Valley it is under 10 inches a year. Thunderstorms occur during the summer months, although seasons may pass without one. The vegetal zones are very clearly defined. Open stands of oak, pine, and cedar, with fringing clumps of manzanita, that grow on the Julian Mesa and

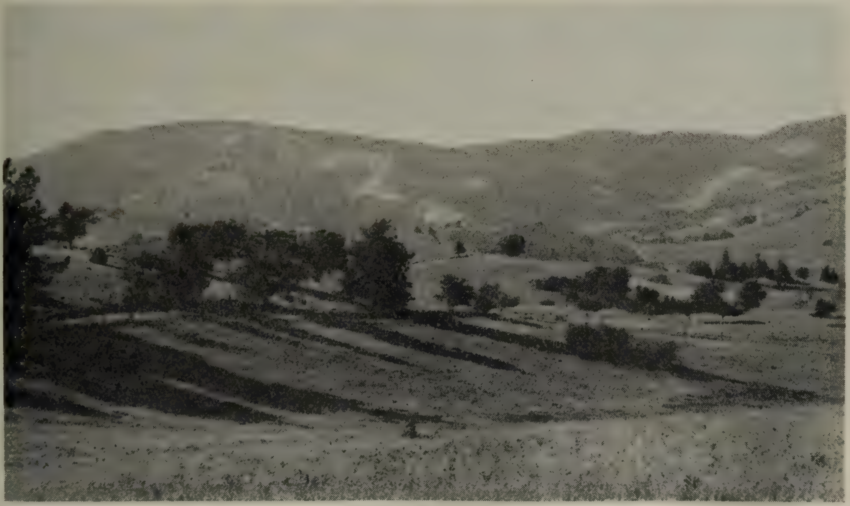

FIG. 2. Julian Mesa, looking north towards Volcan Mountain. The rolling topography is characteristic of much of the upland country of the Peninsular Range.

on Volcan Mountain, give way to the east to thickets of chaparral, which in turn are supplanted by sage-brush thinning to the eastward. Pear and apple orchards are successfully cultivated in the broad valley bottoms and on the slopes of the low hills of the Julian Mesa.

Timber for mining use was formerly cut from local stands of trees, now largely gone. In recent years all dimension lumber for mining and other purposes has been trucked into the district from tidewater at San Diego, although considerable wood is cut for fuel to supply local needs and for shipment to the coast cities of San Diego County.

FIELD WORK AND ACKNOWLEDGMENTS

This paper is a result of field studies carried on in the summer of 1932 and during various short visits in 1933. Airplane photographs and an enlarged portion of the Ramona and Cuyamaca sheets of the U. S. Geological Survey were used in field mapping. The accompanying map is a compilation of data plotted on the engineer's base map prepared by Allen and Rowe, Inc., of San Diego. It is not possible to mention by name the many persons who have assisted in the survey, but the writer wishes to especially acknowledge the courtesies extended by Mr. Sidney Dodge, Mr. Fred Farmer, and Mr. Arthur Blanc of Julian, and Mr. R. Robinson Rowe and Mr. Ernest Childs of San Diego.

The work was made possible by a grant of funds from the California State Division of Mines and a cooperative grant from the San Diego Board of Supervisors, part of which provided the assistance of Mr. J. E. Morrison in the field for three weeks. To Messrs. Rene Engel, Ian Campbell, F. L. Ransome, and J. P. Buwalda, of the Balch Graduate School of the Geological Sciences in the California Institute of Technology, the writer is particularly indebted for helpful suggestions and criticisms.

PREVIOUS GEOLOGIC WORK

Previous detailed geologic study of the Julian region is confined to an investigation, mainly petrographic, by F. S. Hudson [1] who gave the gold-bearing quartz deposits only a passing examination. Carl Sauer [2] has written his views on the genesis of the land forms as developed in this and neighboring region to the north. Certain reports of the State Mineralogist [3] of California contain general mining information of the region. The reports of R. W. Raymond [4] contain accounts of the early and productive epoch of the camps.

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[1] Hudson, F. S., Geology of the Cuyamaca Region, of California, with special reference to the origin of the nickeliferous pyrrhotite: Bull. Univ. Cal., Publ. Dept. Geol. Sci., vol. 13, pp. 175–252, 1922.

[2] Sauer, Carl, Land forms, Peninsular Range of California: Univ. Cal. Publ. in Geography: vol. 3, pp. 199–290, 1929.

[3] State Mineralogist's Reports VI, VIII, IX, X, XI, XII, XIII, XIV, XVII, XVIII, XX, XXI contain information on Julian district.

[4] Raymond, R. W., Mineral resources of the States and Territories west of the Mississippi, Reports for 1870 to 1875, inclusive. Washington, 1872–1877.

GEOLOGICAL FORMATIONS

JULIAN SCHIST

General Features and Distribution.

Isolated bodies of metamorphic rocks of sedimentary origin have been reported from many places in the Peninsular Range. They occur mainly as roof pendants or flanking bodies having the same general strike as the northwest trend of the range; all have steep dips. Apparently the bodies lying within the batholiths of the range owe their preservation to downfaulting or downfolding. They are found both in valleys and along the summits of the present-day topography. The dominant tectonic lines of the range bear northwest and almost all of the structural units of the range—granitic intrusions, bodies of slates and schists, major pegmatite dikes, sedimentary beds of Cretaceous and Tertiary age—are related to these lines.

Numerous bodies of schist are found in the Julian region; the largest, most continuous, and economically most important schistose mass is an elongated, curved body which extends without a break from northeast of Wynola to the vicinity of Rattlesnake Valley, somewhat over twelve miles. The width of this body varies from a maximum of a mile and a half just southeast of Julian to about a half a mile near the trail from the Gold Queen Mine into Chariot Canyon; the average width is a mile. This will be referred to as the main Julian schist body. Of the other mapped masses, an important one extends almost due north four miles from the base of Stonewall Peak to the vicinity of Harrison Park. The abandoned and caved workings of the once productive Stonewall Mine are located in the lobate end of this body of schist which like many of the schist masses in the vicinity of Pine Hills, occurs as a screen between the Cuyamaca Basic Intrusive and the Stonewall granodiorite. There are many small bodies of schistose rock southwest and northeast of the main Julian schist which are not sufficiently large to have warranted field mapping.

Constituents of the Formation.

The main constituents, making up more than nine-tenths of the bulk of the main body, are (1) fissile quartz-muscovite-biotite schist, (2) slightly to highly contorted quartz-muscovite-biotite schist, (3) quartzite, more or less impure, and (4) coarse schist, including paragneiss and injected gneiss. Less abundant constituents are actinolite and amphibolite schist, and blunt-end lenses of a quartzose pyroxene-hornblende rock.

The fissile quartz-muscovite-biotite schist is composed of biotite, muscovite, and quartz in fissile schistose layers. Minor minerals are plagioclase, graphite, iron oxides, and scanty rutile and apatite. Quartz is very often concentrated in tiny veins, in knots or clumps of venous appearance, and in flattened quartzitic lenses. Because of the ease with which the rock disintegrates, exposures are poor where removal is relatively slow, as on the Julian Mesa. Much of the biotite has been hydrothermally altered to bleached biotite. The middle portion of the main schist mass is chiefly the fissile quartz-mica schist above described. It probably makes up more than half of that body.

The fissility, schistosity, and bedding are parallel, as evidenced by (1) the concordance of attitude of these structures, particularly on weathered outcrops, (2) the lithologic variation across the strike of the schistosity, and (3) the agreement in attitude between the quartzite beds and schistosity.

Fine-grained schist similar in composition to the fissile variety but more or less contorted and poorly or nonfissile is common in the middle portion of the main body. It probably ranks with coarse schist and paragneiss in the relative order of abundance, being exceeded by fissile schist and by quartzite. Mica (biotite and muscovite) is developed in about equal proportions with quartz in a considerable part of this rock.

Intercalated within the fissile schist, as well as forming important masses itself, are numerous thin beds of a more or less impure quartzite, containing essentially quartz and subordinate quantities of biotite and muscovite. Graphite and iron ores occur to a small extent. All gradations from a relatively pure quartzite to a fissile and nonfissile quartz-mica schist are found. Quartzite forms extensive bodies in the vicinity of the Ready Relief Mine; in the middle of the main body near Kentwood-in-the-Pines and elsewhere; and along the western border of the main body, where a bed several hundred feet thick is exposed for a distance of over two miles. By virtue of its superior resistance to erosion the quartzite beds affect the topography markedly; many of the elongate ridges with a northwest trend are underlain by these rocks. Some of the quartzite breaks into rectangular blocks that could be used for building purposes.

At many of the contacts between schist and granodiorite are found coarse-grained schistose rocks designated coarse schist in the field. They are commonly more resistant than surrounding rocks and yield ridge-like outcrops. Along the western border of the main body they form a zone varying from a few hundred feet to a half-mile, on the eastern border a thinner zone occurs wherever mica schist makes up the bulk of the schist near the contact. In numerous places throughout the interior of the main mass, foliated rocks coarser than the typical fine-grained fissile schist are found. These rocks may be divided into coarse schist, secondary-cleaved schist, paragneiss, and injection gneiss. They have all apparently been formed by the contact metamorphic effect of granodiorite intrusion. Coarse schist contains essentially quartz, biotite, and muscovite, in a coarser-grain size and with a closer-knit texture than in the fissile schist. The secondary-cleaved schist very frequently contains in addition to these minerals, the thermal metamorphic mineral, andalusite, in long white prisms. The structure of this rock, in which a secondary foliation at variable angles with the primary banding has been developed by thermal effects, possesses much petrographic interest and significance. Paragneiss and injection gneiss, including pegmatitic gneiss, contain large amounts of injected igneous material, largely acid plagioclase, orthoclase (in some of the rock specimens), and quartz. Tourmaline and andalusite are also present in certain of these rocks, particularly in the paragneiss.

Layers of amphibolite and actinolite schist intercalated in the schist series are common and in places form bodies of considerable size. Coarse, long-fibered, green antinolite, with or without quartz, plagioclase, and apatite. make up the actinolite schist. The amphibolite schist consists largely of fine-grained green hornblende and basic plagioclase.

Origin of the Julian Schist.

(1) The presence of beds of quartzite paralleling the primary banding, (2) the lithologic variation normal to this banding, indicative of sedimentary bedding, and (3) the mineralogic composition, point unmistakably to the initial sedimentary nature of the Julian schist. Many weathered outcrops of the less metamorphosed fissile schist resemble thin-bedded sediments more than weathered crystalline schist. The Julian schist series represents the product of load, regional, and contact metamorphism of relatively pure quartz sandstones, clayey sandstones, and clay-mudstones. The fissility parallel to the bedding is believed to have been developed by processes induced by superincumbent load. The layers of amphibolite and actinolite schist are interpreted as the products of metamorphism of andesitic and basaltic lavas.

Structure of the Julian Schist.

The schistosity (which is parallel to the stratification) of the main body of the Julian schist strikes northwest in varying degrees, the westward component increasing as one goes northward along the outcrop from the southern limit near Rattlesnake Valley. The strike almost uniformly agrees with the direction of the nearby schist-granodiorite contact, a generalization that holds good for most of the smaller bodies of schist. The dip of the rocks of the main body, as they are encountered in going from west to east is first steeply northeast (70–80°), then steeply to gently inclined southwest (average 60–70° SW., but varying from horizontal to vertical), and still farther east again steeply northeast (75–80°). This change in dip has been interpreted as indicating the existence of several outcropping limbs of sharply compressed folds. The writer has observed, however, that the pronounced southwestward dips are all on east or northeast facing slopes. The evidence collected is conclusive that southwest or nearly horizontal dips in the schist of the main body are due to downhill creep or bending. The effect is superficial and diminishes rapidly beneath the surface, so that in depth the schistosity dips in the whole body northeast at a high angle.

A study of the drag folding in the main Julian schist body leads to the conviction that the axes of most of the major drag folds plunge northwest at low angles, up to 25°. Taken in conjunction with the effect of downhill creep, such a generalization permits the following interpretation of the broad structure of that body.

In summary, the main body of the Julian schist is structurally the eastern limb of a northwest-plunging anticline in which the rocks strike northwest and dip at high angles northeast except where superficially bent southwest by downhill creep on east-facing slopes of strong relief. Contact metamorphism following the intrusion of Stonewall granodiorite has affected the body, particularly the margins, both structurally and mineralogically, and broad warping, probably during the same intrusion, has produced the crescent shape now seen in plan. Beneath the schist the contact between it and the granodiorite dips at low angles from both sides, the result being a wedge-shaped cross-section of schist of no great depth. This bottom contact with granodiorite appears to be irregular, judging by the presence of contact metamorphism well within the body.

Age of the Julian Schist.

The age of the Julian schist has not been definitely and accurately determined on the basis of paleontological evidence. Because of lithologic and structural features it is tentatively assigned to the Juratrias. By various writers it has been correlated with the Calaveras formation (mainly Carboniferous)[5] of the Sierra Nevada and with the Santa Ana slates (upper Triassic)[6] of the Santa Ana Mountains.

MAJOR IGNEOUS ROCK BODIES

The predominant rocks of the Peninsular Range are coarse-grained intrusives, in places more or less gneissic, which vary in composition from gabbro to granite. The average rock of the batholith is probably a quartz diorite.

In the Julian region three kinds of intrusive rocks occupying rather large areas have been mapped; namely, quartz diorite-granodiorite, norite-gabbro, and a true granite. Following Hudson in part these rocks are called (1) Stonewall granodiorite, (2) Cuyamaca basic rocks, and (3) Rattlesnake granite. Certain of the aplite dikes and pegmatite bodies have also been mapped.

Stonewall Granodiorite.

The Stonewall granodiorite rock is typically exposed in Stonewall Peak, from which the name has been taken. The areas mapped as granodiorite include rocks that compositionally are quartz-dioritic and granodioritic, and structurally are massive to rather highly gneissic. The rocks weather to rounded, knob-like forms that frequently project from the thin detrital and soil cover in monolithic shapes. These low eminences are especially common in the neighborhood of Lake Cuyamaca. They are not due to glaciation.

Megascopically these rocks are medium to coarse-grained aggregates of feldspar, quartz, and biotite, and in the more basic varieties, hornblende. Swarms of orthoclase phenocrysts are found in the granodioritic facies, usually near schist. Good exposures of such porphyritic granodiorite occur in the Oriflamme Mine.

Microscopically all of these rocks were found to contain plaioclase having a composition varying from oligoclase to andesine. In a majority of the rocks primary orthoclase is present in varying amounts but always less than the plagioclase. Quartz is an essential constituent in all the microscopic slides examined. Biotite occurs in greater or lesser amounts in all the specimens studied microscopically. Green hornblende is present as a minor constituent in the rocks determined as quartz diorite and scant amounts of pyroxene were also noted. Minor quantities of muscovite were found in orthoclase-bearing rocks near schist-granodiorite contacts.

A striking feature of most of the microscopic slides examined is the development of secondary textures by deformation and by replacement due to post-consolidation processes. In the main, the first process in which cataclastic textures are produced, goes on hand in hand with he second, in which new minerals are formed by solutions introduced nto the rock. However, specimens were examined that showed as secondary textures only one or the other. The solutions that effected replacement at first, apparently deposited quartz, later inter-growths of albite and quartz known as myrmekites, and finally fine-grained intergrowths of quartz and alkali feldspars. Tourmaline and abnormal orthoclase, or isorthoclase, have been recognized in a few of the thin sections of rocks that have been subjected to corrosion by replacing solutions.

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[5] Merrill, F. J. H., Geology and mineral resources of San Diego and Imperial Counties: 14th Rept. State Mineralogist, pp. 653–662, 1914.

[6] Fairbanks, H. W., Geology of San Diego; also portions of Orange and San Bernardino Counties: 11th Rept., State Mineralogist, pp. 76–120, 1893.

The volume distribution of orthoclase, considered in connection with the structural evidence given below, lends probability to the statement that the granodioritic phases have been derived, at least in part, through assimilation by quartz dioritic magma of schistose material. The extent of post-consolidation replacement depends, apparently, on the closeness of foliation in the granodiorite, which in turn depends on the nearness to schist bodies.

The Stonewall granodiorite has intruded the Julian schist as evidenced by (a) the foliation developed within the granodiorite near the schist contact, (b) the presence of numerous oriented xenoliths of schist in the granodiorite, (c) the presence of igneous material in the schist near the contact, (d) the zones of pneumatolitic and normal contact metamorphism at the margins of the schist bodies where they are in contact with granodiorite, (e) the finer grain size of the granodiorite in places near the schist contact.

The character of the foliation in granodiorite may be said to be a function of the nearness of schist bodies. Along the immediate contact with such bodies the foliation in the granodiorite is sharp, the layers are thin and have the same general trend as those of the contiguous schist. Away from the contact the folia in the granodiorite increase in thickness and decrease in sharpness. From (1) the increased percentage of orthoclase in the granodiorite nearest the schist contact, (2) the presence of oriented xenoliths, especially of quartzite, in granodiorite near the contact, and (3) the very close relation between the attitude of the gneissic texture and of the schistosity; it is concluded that the gneissic texture in granodiorite is relict after the schist.

Cuyamaca Basic Intrusive.

The Cuyamaca Peaks are made up almost wholly of basic rocks, principally norite and gabbro. These rocks have no apparent relation to gold deposition and are considered summarily here. In brief, they are fine-grained basic rocks containing basic plagioclase, pyroxene (hypersthene, augite), olivine, hornblende, small amounts of pyrrhotite, along with certain other minor minerals.

The Cuyamaca basic mass intrudes the granodiorite and schist and hence is younger than these. Several small isolated bodies of gabbroic rocks are mapped as being contemporaneous with the main mass of the Cuyamaca Peaks. The endomorphic and exomorphic effect of the basic rocks near their contact with others has been slight, some freezing denoted by decreased grain size has been the chief endomorphic change. The walls of the Cuyamaca basic intrusive dip under it, so that in cross-section the body has the shape of a downward-pointed wedge. In horizontal plan the body is irregularly elongated north and south.

Such an injected igneous mass is termed a chonolith; in this case the intrusion took place rather quietly.

Rattlesnake Granite.

A true granite, consisting of very coarse-grained orthoclase, quartz, and muscovite, and exiguous biotite, outcrops near the southeastern limits of the map. Orthoclase is commonly developed in white or pinkish white carlsbad twins and the quartz in some of the specimens collected has a pronounced bluish tinge.

The formation has no apparent relation to the gold quartz deposits and has not significantly metamorphosed the schist it has intruded. The intrusion has been somewhat vigorous as attested by variations in the dip of the schist nearby.

DIKE ROCKS

Aplite.

In the eastern part of the Cuyamaca Grant, an aplite dike, broken in the middle, averaging 10 feet in width and 2 miles in length, has been injected into the schist series. The attitude of the dike coincides with that of the encasing schist; the strike is slightly west of north at its northern end and the dip steeply east. The dike stands out sharply from the country rock. Minor off-shoots strike to the northeast and disappear in the schist. Microscopically the aplite is made up of corroded phenocrysts of quartz and andesine, with subordinate orthoclase, in a fine-grained, parallel-textured groundmass of quartz and scanty muscovite and hornblende. Megascopically the rock is sugary in texture, possesses a rude foliation, and is white in color except where slightly iron-stained.

Pegmatite.

Pegmatite dikes cut all the crystalline rocks in the Julian region and in places, as along the old Banner road, form large irregular-shaped masses. Most of them may be classified as simple granite pegmatites, containing quartz, orthoclase, and muscovite. Well crystallized black tourmaline is found along with quartz in bands and clumps in some of the dikes. Lithia pegmatites, similar to those of Pala and Mesa Grande outcrop on the southwest slopes of Granite Mountain, east of the boundaries of the map. A close relation exists between the pegmatites and the gold-quartz deposits, the deposition of the gold-quartz bodies being here viewed as lower temperature phenomena than the pegmatites in the same general post-consolidation processes. Some of the pegmatites have been prospected and occasionally contain up to 2–3 pennyweights of gold per ton.

Barren Quartz Veins.

The gold-bearing quartz deposits will be discussed under the section on ore deposits. The other type of quartz vein or 'dike,' the barren quartz or 'bull' quartz of the miner, occurs extensively in the schist and granodiorite; it may be regarded as a siliceous end phase injection associated with granodiorite intrusion, as opposed to the presumably hydrothermal phase of gold-bearing quartz deposition.

A close relation exists between these barren quartz veins and pegmatite veins or dikes. Transitions along the strike from barren quartz veins to pegmatite veins are found. The quartz phase may be interpreted as being a pegmatite-like injection in which quartz has been the only mineral deposited. Some of the 'bull' quartz is not wholly barren, but contains a few pennyweights in gold per ton.

Dark-colored Dikes.

Dark-colored dikes are found cutting the basic rocks and granodiorite. The composition is variable. One specimen collected from a dike cutting gabbro contains hornblende and labradorite, with a small amount of magnetite; this rock may be called a camptonite. Another specimen from a tabular body in granodiorite contains hornblende (green), quartz, and acid plagioclase, with some pyroxene. It appears probable that the two dikes here cited are not genetically related.

AGE OF THE IGNEOUS ROCKS

All of the igneous rocks are younger than the Julian schist which they intrude. They are probably upper Mesozoic in age and, on the basis of regional considerations, to be correlated with the post-Mariposa intrusions of the Sierra Nevada.

The relative ages of Stonewall granodiorite, Cuyamaca basic intrusive, and Rattlesnake granite are in the order of intrusion: (1) granodiorite, (2) granite and basic rocks. The relation between the Cuyamaca basic intrusive and Rattlesnake granite is not clear; the probabilities are that the basic rocks are younger. The evidence pointing to such a view is the inferred lesser depth of cover during the intrusion of the basic rocks, as deduced from their much finer grain size and more quiet mode of intrusion in comparison with the Rattlesnake granite.

RECENT ALLUVIUM

In many of the depressions throughout the region recent unconsolidated alluvium has been deposited. In the open valley to the north of North Peak one of the branches of Cedar Creek has cut deeply into alluvium and cliffs 20 feet or more in height are exposed. Laid open in these cliffs are rudely-stratified, poorly-sorted layers of angular and subangular fragments, which in the upper two-thirds are largely weathered to a dark brown soil. A few feet from the top are lenses of boulders at an accordant level. Intercalated in the alluvium is a bed of dark, carbonaceous material, apparently the result of the burial of vegetal material. This last feature is seen in the tract in a number of stream cuts. The recent deposits of San Felipe Valley are also alluvial, the result of inwash from the surrounding higher lands.

Throughout the Peninsular Range the alluviated bottoms of many of the upland valleys are being dissected, in some cases very rapidly. This may mean rejuvenation of streams due to a very recent seaward tilt, or increased erosion because of deforestation and cultivation. It is much more likely that cultivation and deforestation are responsible. The makeshift devices that have been installed in places to decrease erosion generally aggravate the situation.

STRUCTURAL GEOLOGY—FAULTING

One of the principal fault zones of southern California, called the Elsinore fault zone because of its remarkable development near the town and lake of that name, passes through the Julian region. In the little-known country south and east of Julian the location of the trace of this fault zone is conjectural.

BANNER FAULT

The section of the Elsinore fault zone in Banner, Ranchita, and Rodriquez Canyons is called here the Banner fault. The evidence for faulting along the Banner-Rodriquez line is divisible into three headings: namely, (1) physiographic, (2) structural, and (3) seismic.

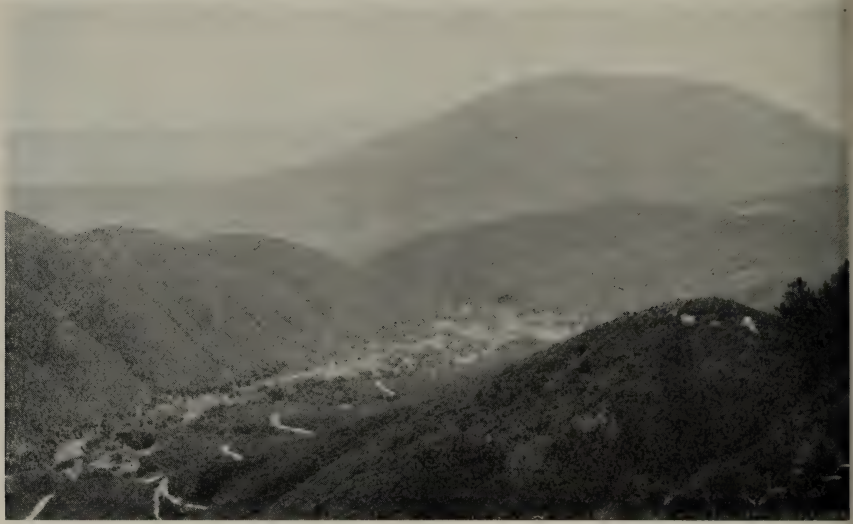

FIG. 3. Looking down Banner Canyon, the local expression of the Elsinore fault zone. The site of Banner town lies in the alluviated floor in the middle of the picture.

Physiograhic Evidence.

a. Remarkable straightness and linear continuity of the three canyons involved, Banner, Ranchita, and Rodriquez. The straightness is even more striking in aeroplane photographs than on topographic maps.

b. Asymmetry of the canyons, especially Banner Canyon, the east side of which is little dissected and has little debris at its base, the western side is much dissected. This evidence is complicated in places by different rock types occurring on opposite sides of the fault-controlled canyon.

c. The suggestion of depressed, poorly drained blocks, or small grabens along the fault zone.

d. Springs along the fault trace, as in Ranchita Canyon southwest of Ranchita Mine. Hot springs are reported in Rodriquez Canyon.

e. Correlation of two old-age erosion surfaces—(a) the Julian Mesa, and (b) the summit portions of Volcan Mountain, now separated y a vertical distance in excess of a thousand feet.

f. Sliced benches or parallel ridges on the eastern side of Banner Canyon. They are not continuous nor at the same level. Some of them do not slope downstream.

In addition to the above evidence may be emphasized the prolongation of the Rodriquez-Banner line northwestward to localities of known active faulting.

Structural Evidence.

Gouge and brecciated zones found (1) in road cuts on the Foster grade near the upper part of Banner Canyon, (2) in the Ranchita Mine, (3) in road cuts just east of Banner. The Ranchita gouge zone dips northeast at a high angle, parallels the strike of the fault trace, and has been metallized.

Seismic Evidence.

In the period 1899–1906, for example, 25 earthquake shocks were reported at Cuyamaca. It appears probable that many of them originated from movements on the Elsinore fault zone as no faults in the mmediate neighborhood of Cuyamaca have been found, and many of the shocks were reported on dates when the middle and northern parts of California were seismically inactive. Although the evidence shows conclusively that the Elsinore fault zone has been less active in recent time than the San Jacinto fault zone, it appears probable that the sparsely-settled nature of the country through which the Elsinore zone passes has been responsible for the lack of accumulated information on its activity.

The summary of evidence on the Banner fault supports the view that it is an ancient structural feature along which movement has been in progress for a long time. The fault plane apparently dips under the upthrown block, hence the vertical movement has been of a thrusting nature and the fault is reverse in type. Although no movement resulting in earthquake shocks can be proved to have occurred within the mapped area, it seems probable that movements are to be expected in the future.

There are several other physiographic lines in and near the region that suggest[7] the presence of faults and for most of them faulting is a likely explanation. For the one formed by Chariot and Sweetwater canyons the geologic evidence, however, precludes faulting as an hypothesis of origin.

MINOR FAULTING

Minor faulting at the contact between schist and granodiorite on the east margin of the main body is common. Where exposed by Golden Chariot Mine workings it is stepped and reverse in type; each succeeding step in depth is flatter than the one higher, so that the fault surface as a whole is curved concave upward and dips under the eastern member, granodiorite. Gouge, quartz, sericite, and occasionally calcite and pyrite are developed in the faulted areas. No important cross faults, i. e., those which if existing would have a strike nearly at right angles with the regional or northwest trend, were observed in granodiorite. A cross fault said to occur near the Ranchita Mine could not be found by the writer. Minor faults occur within the schist series, with displacements of a few inches or feet. A few minor cross faults in schist exposed in mine workings in the Ready Relief and North Hubbard Mines strike N. 75 E. and dip at a steep angle (70°) northward.

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[7] Ellis, A. J., and Lee, C. H., Preliminary geologic map of San Diego County. Geology and ground waters of the western part of San Diego County: U. S. Geological Survey, Water-supply Paper 446, 1919.

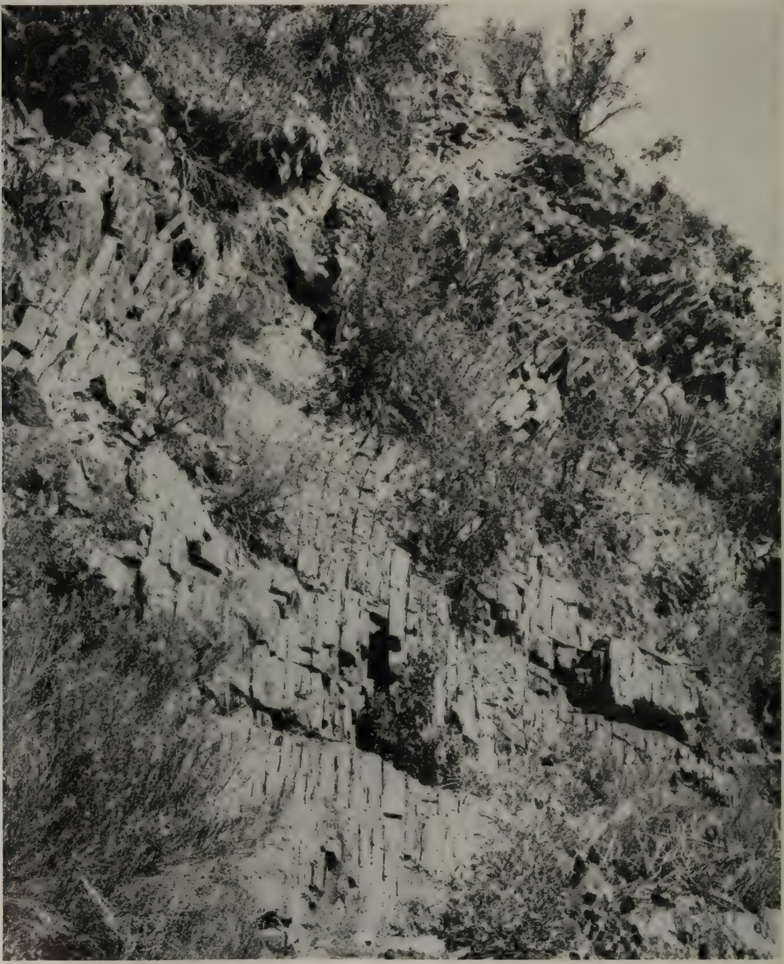

FIG. 4. Bending in schist. Looking northwest along the strike, where the schist dips northeast. This effect is most pronounced where the slopes face east, causing a reversal of dips near the surface to the southwest.

LANDSLIDING

The effect of downhill creep, which is a special case of landsliding, on the structure of the Julian schist has already been considered. The large amount of landsliding in quartz diorite and granodiorite even on gentle slopes is noteworthy. This is produced by the thorough soaking (during brief, heavy rainstorms) of the rather coarse mantle rock developed over these rocks. Landsliding is effected on an especially large scale when a heavy rain is followed within a few days by a second downpour. No landsliding was observed in the heavy, compact soil produced by weathering in the basic rocks.

PHYSIOGRAPHY

In this particular part of the Peninsular Range an intrusive-metamorphic complex, having a general northeast structural trend, was worn down by subaerial erosive processes—weathering and streaming—to a surface of low relief, a peneplain, on which the streams were adjusted to the structure of the underlying rocks. Monadnocks, of which the Cuyamaca Peaks carved in basic rocks are examples, jut above the rolling surface of this peneplain. The Cuyamaca Peaks owe their eminence to superior resistance to erosion compared to the surrounding areas of more acidic rock types—schist and granodiorite. The order of increasing resistance to erosion under the conditions obtaining in the Julian region of the three categories of rocks is granodioritic, schistose, basic. Low etching in rocks containing minerals, such as amphibole and pyroxene, show these minerals standing out in relief against a background of plagioclase, or quartz. Such an order of resistance is contrary to that usually given in textbooks, as for example, that of G. P. Merrill.[8] Renewed uplift along fault lines parallel to the established northwest trend broke up by the peneplain and tilted that portion of it herein called the Julian Mesa gently westward. The portion now preserved on top of Volcan Mountain was uplifted higher and probably in a scissors-like manner, the northern part being lifted higher than the southern part. As a consequence of uplift, westward-flowing streams have eaten headward into

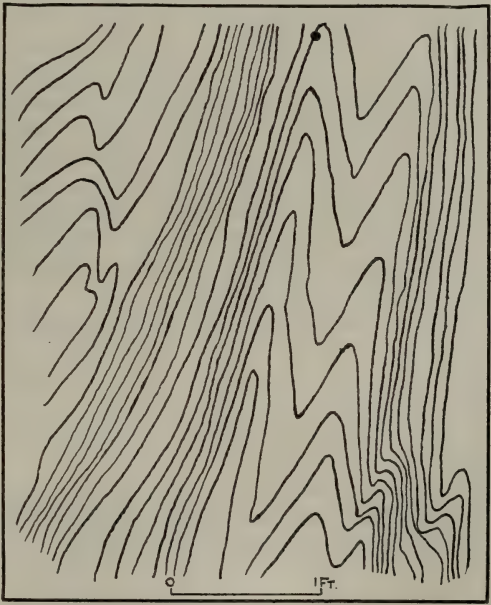

Fig. 5. Minor folding in quartzite exposed in the Ready Relief Mine. The axes of the folds plunge northwest. Observer is looking southeast along the strike.

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[8] Merrill, G. P., Rocks, Rock Weathering and Soils: Macmillan, N. Y. (1921).

the peneplain and one, Boulder Creek, has cut as far back as the site of Cuyamaca dam. Because of increased erosion due to cultivation and deforestation, the smaller streams flowing into the Julian Mesa have in places cut deep trenches (up to 20 feet deep) in the unconsolidated alluvium of the upland valleys. From the east, streams of which Banner and Chariot Creeks are the most important, have eaten into and frayed and complicated the eastern border of the Julian Mesa, but in general there remains a steep eastward-facing scarp, locally quartzite-defended, that forms part of the main drainage divide between the Pacific Ocean and the Salton Sea. Banner and Chariot Creeks unite to form San Felipe Creek which has probably cut an antecedent gorge through the southern part of Volcan Mountain. The physiographic effects on the gold quartz deposits is discussed under ore deposits.

SUMMARY OF GEOLOGIC HISTORY

1. Deposition of mud, clay, and sand in a marine environment at some distance from the nearest land mass. Intercalation of basic lava flows, possibly submarine, in these sediments.

2. Transformation of the claystone and mudstone sediments by load into a fissile shale, in which fissility parallels the bedding.

3. Initiation of compressive forces that broadly folded the sediments, at first at a relatively low temperature.

4. Increase in vigor of folding, increase in temperature. Schistosity, and later, foliation, developed parallel to fissility and bedding. Minor folding increased, places of less compression developed.

5. Intrusion of Stonewall granodiorite. Normal and pneumatolytic contact metamorphism of schist. Gneissic texture developed in granodiorite near schist contacts.

6. Intrusion of Rattlesnake granite. Intrusion of Cuyamaca basic intrusive.

7. High-temperature hydrothermal deposition of gold-bearing quartz deposits.

8. Uplift and erosion, with the stripping of a cover several thousand feet thick.

9. Development of the peneplain by subaerial erosion.

10. Break-up by uplift along bounding faults of this peneplain. Renewed erosion, conditioned by uplift and structure.

ECONOMIC GEOLOGY

GOLD

Validity of the Information.

Any consideration of the gold-bearing quartz deposits of the Julian region must take into account several factors:

1. During the period of greatest mining activity, 1870–75, no detailed competent observations on the ore deposits were made that have come down to us.

2. The mines have not penetrated much beyond the oxidized zone, hence, no complete hypogene suite of minerals is available for study.

3. The most important mines on the Julian Mesa,. Stonewall Owens, and Helvetia, are not accessible and little can be seen on the surface of these mines.

4. During the writer's first visit to the camp practically no mining work was going on, and even the recently-operated Golden Chariot Mine was inaccessible.

The specific remarks made in this report in application to the mineralogy, structure, and genesis are based on information which is certainly incomplete, and in some respects wholly inadequate. In spite of this, conclusions have been reached that are tenable and may prove valuable in prospecting in the district. On the whole, the report should be considered as a framework of highly probable geologic interpretation which may be amended and amplified by the future observations of all those interested.

History.

Toward the close of 1869 a party of ex-Confederate soldiers drifted into the vicinity of what is now the Julian district. Driven from their homes in Georgia by the economic collapse of the South during Reconstruction, Mike and Webb Julian, James and D. D. Bailey, had prospected in Montana and Arizona with little success. Placer mining on a small scale was by this time no longer profitable in these States, all the rich ground accessible without the expenditure of capital was worked out, and a general exodus to more remote districts took place. In November, 1869, these men and others organized the Julian or the Cuyamaca mining district and during December worked placers on Coleman Creek near Wynola in a small way, apparently attempting meanwhile to trace the origin of the float gold. It is related that on February 22, 1870, a boy in search of firewood in a small ravine north of Julian found gold under the roots of a blown-down tree on what was called, after the date of its discovery, the George Washington claim. The Van Wert, about a half mile northeast of Julian, was located the same day. The first town, Tent City, was laid out in the small valley east of Julian on the Volcan road.

C. C. Parry,[9] W. P. Blake,[10] Thomas Antisell,[11] and J. S. Newberry[12] made geological and topographical reconnaissances across the mountains from San Diego to the Colorado Desert in the decade 1849–59. Most of these exploratory parties followed the now little-traveled route: San Diego-San Pasqual-Santa Ysabel-Warners-San Felipe-Vallecito-Carrizo Creek, and the Colorado Desert. C. C. Parry, however, in the fall of 1849 followed a route now taken in part by the improved highway from San Diego to Julian and the Imperial Valley. Of his observations made while traveling down Banner Canyon to join the main road in San Felipe Valley, Parry records "the geological formation exhibited along the eastern slope (along the west wall of Banner Canyon) of the mountain range at this point shows a very sensible change, and in place of the usual forms of feldspathic or quartz granite we meet a more prevalent character of micaceous granite, in which the scales of mica are frequently of large size, and very confusedly intermixed. With this also occur mica and talcose slates, traversed by quartz veins. At this point, then, we have an approach to the gold formation, and in the section of country thus limited, exist the fairest prospects of mineral discoveries.'' Over twenty years after Parry made this note, gold was found in these quartz veins.

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[9] Parry, C. C., Reconnaissance to the mouth of the Gila River from San Diego, California. Rept. U. S. and Mexican Boundary Survey: vol. 1, 34 Cong. 1 Sess. Ex. Doc. No. 135, pp. 125–130, 1857.

[10] Blake, W. P., Pacific Railroad Surveys: vol. V, Part II, 33 Cong. 2 Sess. Ex. Doc. 78, Chap. VIII, IX, and X, 1856.

[11] Antisell, Thomas, Pacific Railroad Surveys: vol. VII, 33 Cong. 2 Sess. Ex. Doc. 78, pp. 119–129, plate VIII, fig. 1, 1857.

[12] Newberry, J. S., Colorado River of the West (Exploration): 36 Cong. 1 Sess. Ex. Doc. No. 90, 1861.

Up to August 30, 1870, records of 54 claims had been accepted for filing in the Julian mining district by M. S. Julian. These included the Owens, High Peak, Eagle, Van Wert, Hayden, George Washington, Shamrock (not the present claim), San Diego, and others.

The discovery of gold in the Banner district did not come, as one might suppose, from prospectors working southeastward from Julian along the strike of the veins. In August, 1870, a party of men from Julian while looking for wild grapes in southern San Felipe Canyon, as Chariot Canyon was then called, found the vein named from one of its discoverers, the Redman. Both the vein, 3 feet wide, and the sands of the nearby creek were rich in gold. In a few days after this discovery the steep and chaparral-covered slopes of Banner and Chariot Canyons were alive with prospectors and the Ready Relief, Hubbard, Kentuck, Madden, Antelope, Chaparral, and many other claims were located. Two of the most important mines in the area were among the last to be located, the Helvetia, about a mile east of Julian, was found late in 1870, and the Golden Chariot, two miles south of Banner, was discovered in February, 1871.

During the early and vigorous epoch of mining activity which brought at its peak 700 people to Julian and 300 to Banner, these towns constituted the centers of separate mining districts. In 1881 the two districts were consolidated into one and the boundaries of the newly formed Julian Consolidated Mining district were made to also embrace several unimportant districts, including the Desert Mining district, some miles southeast of Banner and containing the Oriflamme Mine, and the Indian Mining District, a short distance northwest of Julian. Later nearby discoveries, like the Gold King and Gold Queen, the Ranchita and Elevado, were grouped in the Julian district.

The absence of capital in the period 1870–1874 has been explained as a consequence of a suit brought in 1870 by the owners of the Cuyamaca grant who attempted to 'float' their boundaries to include the Julian district. The United States Land Office finally decided in July, 1874, in favor of the Julian miners. Another cause for the scarcity of foreign capital at the same time has been assigned to the prejudice existing during this period in northern and middle California against the 'lower' country or southern California.

Production reached a maximum in the Julian and Banner districts in 1874 and declined very rapidly thereafter. The greatest annual production, that of 1874, was probably slightly in excess of $500,000. The production estimates include the returns from the Stonewall Mine, which although not a part of the Julian Mining district at any time during its history, is reported in the meager literature with the mines of the Julian belt and is described in this report. In 1876 the Golden Chariot closed down, and according to the report of R. W. Raymond for 1875 most of the mines and mills were idle.

The discovery of the Gold Queen and Gold King mines four miles southeast of Julian in 1888, almost twenty years after the main discoveries, infused new vigor to prospectors. The development and the building from San Diego to Foster of the Cuyamaca Railroad, under construction in 1888, probably also helped to stimulate mining activity, so that in 1889 work was resumed on many of the Julian mines and some rich ore discovered. In 1890 many of the mines were taken over by more or less strongly financed companies and although it is probable no large amount of gold was produced by them, their exploratory work, coupled with the system of leasing inaugurated about this time, and the general industrial condition of the Nation, resulted in considerable gold production during the nineties. In 1891 the first claim map of the district was compiled by D. D. Bailey, J. E. Chamberlin, and W. A. Sickler; a revision of this map was made in 1896. In 1894, 20 mines were operating in the Julian district and some time in the following year the Ranchita and Elevada mines were discovered. The Stonewall after attaining a depth of 600 feet and a production record of $2,000,000 closed down in 1893 and has never been reopened. The Owens Mine, abandoned in 1889, was unwatered and reconditioned at considerable expense in 1890–91, but this attempt at reopening failed; in 1896 operations had been resumed and some good gold-bearing quartz was found.

In the first two decades of the twentieth century almost no substantial mining ventures were under way in the Julian district. A small amount of ore was found in 1910 on the southwest slope of Granite Mountain in what was called the Granite Mountain Mine. During 1913–14 attempts were made to work the Golden Chariot. In March, 1923, the Golden Chariot Mine was taken over by the Golden Chariot Mining Corporation and a formidable program of exploration was projected. In the latter part of 1923 the Ready Relief and contiguous mines were consolidated and considerable prospecting is reported to have been done in the next few years. A number of smaller mines were being worked in this same period. The total amount of gold produced in the Julian district by the mining operations in the years 1923–33 was 2057 fine ounces, value $42,940, about 10 per cent of which was from placers. In the fall of 1932, after an alleged expenditure of $300,000 with only a small return in gold production, most of the surface plant of the Golden Chariot Mine was dismantled and removed from the property.

During the writer's visit in the summer of 1932 scarcely any mining work was being done. The moratorium on mining claim assessment work for the year ending July 1, 1932, and the expected continuation of this moratorium for the next year, virtually stopped all development work.

In the spring of 1933 the records of the Julian mining district were moved to the office of the county recorder in San Diego, and the legal existence of the district was by that act brought to an end, so that in common with most of the mining areas in California the term Julian mining district has lost its significance. The increase in the price of gold ($35 per troy ounce on January 31, 1934), from the former stable price of $20.67 per troy ounce, may cause a renewal of mining activity in the Julian region. A little work was going on in the Ready Relief group during the writer's visit in the fall of 1933.

Production.

The gold production during the early years of mining activity, from 1870 to 1876, can only be inferred. For the early production no records are available which are even approximately based on statistical information. The following figures represent estimates founded on fragmentary sources:

1870	$150,000	
1871	175,000	
1872	490,000	(10,000 tons of ore crushed)
1873	500,000	(10,500 tons of ore crushed)
1874	190,000	
1875	100,000 or less	
1876	100,000 or less	

Mr. Chester Gunn of San Diego, California, estimated the total production for 1869–1880 at over $2,500,000. As an indication of how the estimated amount of total production increased by passage of time, the Julian *Sentinel* in 1889 reported the total production of all mines at well over five million dollars, despite the small amount produced in the eighties.

In a publication issued by the San Diego Chamber of Mines in 1927 entitled "San Diego County Mines & Minerals" the total gold production of the Julian belt since 1880 is stated to be approximately $7,500,000, an amount about equal to the published production records of the State Mineraligist for San Diego County for the same period. The records of the State Mineralogist prior to 1907 include the gold production of what is now Imperial County, which was a part of San Diego County until that time, and, while there is no way of correctly allocating the production emanating from the Julian belt, the whole amount can not be credited to the Julian Mines.

The total production of all mines in the Julian-Banner-Cuyamaca region is believed to be between $4,000,000 and $5,000,000. The estimated production for individual important mines tabulated in appropriate order of rank is as follows:

Stonewall	$2,000,000
Golden Chariot	700,000
Ready Relief	500,000
Helvetia	450,000
Owens	450,000
Blue Hill or Gardiner	200,000
North Hubbard	200,000
Ranchita	150,000

The Antelope, Chaparral, Cincinnati Belle, Eagle, Elevado, Hidden Treasure, High Peak, Kentuck S., Madden, Redman, San Diego, Shamrock, Van Wert, Warlock, and Washington probably produced between $25,000 and $50,000 each.

The Cable, Chieftain, Eldorado, Ella, Fraction, Gold King, Gold Queen, Granite Mountain, Hidden Treasure, Homestake, Neptune, North Star, Oriflamme, Padlock, Ruby, South Hubbard, and Tom Scott are believed to have produced less than $25,000 each.

General Geologic Features of the Gold Deposits.

It has been shown[13] that most of the gold output of the Pacific coast belt has been derived from fissure veins or from deposits which possess close relationship to fissure veins. These fissure veins and allied deposits are believed to have been formed chiefly by ascending hot waters, which had their origin in batholithic intrusions of Mesozoic age. Such intrusion can be traced from Baja California, through San Diego, Los Angeles, and Kern counties, northwestward to Nome, Alaska, on the Seward Peninsula. It is obvious that the gold deposits of the Julian region are not the continuation or prolongation in southern California of the Mother Lode system of the Sierra Nevada. Instead it may be said similar conditions of ore deposition obtained in both areas at somewhat the same time.

The deposits contained wholly or partly in schist have been much more productive and are described in greater detail than those contained in fractured, sheared, or metamorphosed granodiorite.

Gold-bearing Quartz in Granodiorite.

Gold deposits in more or less metamorphosed granodiorite are represented by the Ranchita Mine, Gold Queen Mine, and a few other mines and prospects. They are much less important than those in Julian schist. At the Ranchita Mine, which was a large producer, a zone of granodiorite with what are probably schist xenoliths, has been converted by shearing into a mica schist now highly weathered and containing much black gouge. Lenses and stringers of quartz carrying free gold have been deposited in this shear zone, which has an average strike of N. 50° W. and dips about 60° NE. The Elevada prospect, just northeast of the Ranchita Mine, possesses a similar structure except that it dips southwest. The Gold Queen Mine is located near the contact between a small body of injected schist and gneissic granodiorite. Little is known of the mine except that it worked a small shoot of rich, free-gold ore. Other similar deposits of small highly-irregular gold-bearing quartz veins are not uncommon but have yielded a very small gold production.

Gold-bearing Quartz in Julian Schist.

The gold-bearing quartz deposits associated with Julian schist are mainly in a belt that cuts diagonally across the main schist body from the northwest nose of the hill just north of the town of Julian to the vicinity of Banner. Only two mines, but both of these important ones, are outside this belt, namely, the Golden Chariot Mine situated two miles south-southeast of Banner in the main schist body at the contact between gneissic granodiorite and schist, and the Stonewall Mine in the southern lobate end of a schist body entirely separate from the main Julian body. The distribution of the main belt led some of the earlier investigators to conclude erroneously that there were four main veins traversing the district. There is no evidence whatever for the existence of four such veins.

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[13] Lindgren, Waldemar, The geological features of the gold production of North America: Tr., A. I. M. E., vol. XXXIII, pp. 790–845, 1903.

Gold-bearing quartz occurs in all the various types of schist described, but it is more common and forms larger bodies in some types than in others. The bodies in richly-siliceous rock, as in the Ready Relief Mine and in the mines adjacent to the north and south, are the largest in size and the most continuous along the strike. Many of the others are encased in mica schist that shows evidence of contact metamorphism; e.g., those of the Madden, Helvetia, Owens, and nearby mines.

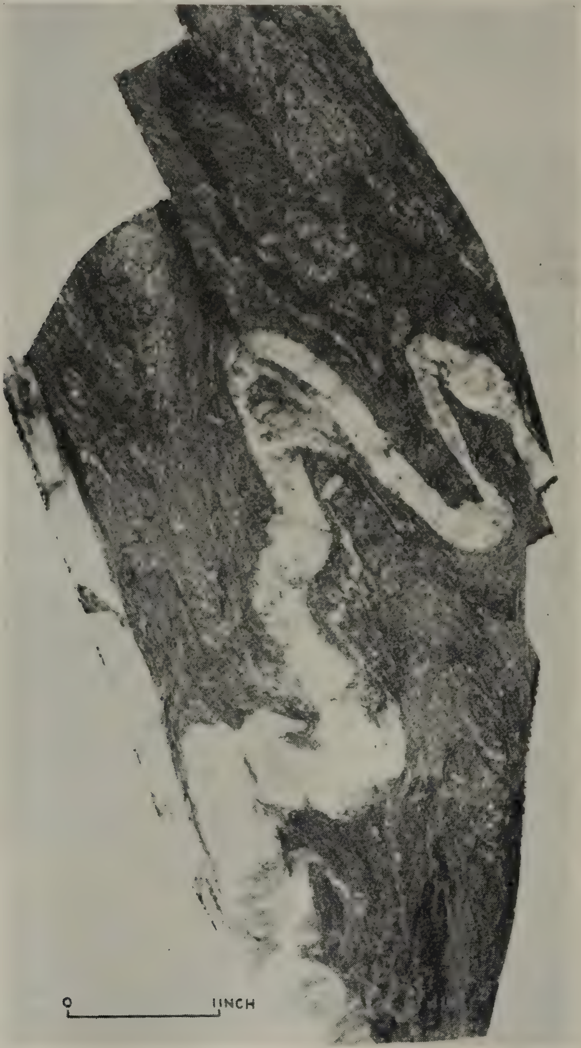


FIG. 6. Quartz roll from the North Hubbard Mine. The rock is silicified mica schist.

The richest and most characteristic ore consists of layers of quartz from a mere film to a few inches thick interlaminated with comparablysized schist layers, the whole carrying a subordinate amount of auriferous simple sulphides (or their oxidized derivatives) and free gold. The layers of quartz are commonly thicker and more persistent than those of schist. All gradations are known to exist from a very thin-banded ore to that in which quartz forms massive layers a foot or more thick. In much of the ore mined during the heyday of the camp, free gold is reported to have occurred in amounts visible to the unaided eye and the ore constituted what was then called 'specimen rock.'

Occurrence and Structure.

The gold-bearing quartz bodies are classified according to shape as (1) lenses, (2) lenticular veins, and (3) rolls. They have all been formed during the same period of ore deposition by related causes, but for convenience they are classified separately.

Lenses of vein quartz are abundant in the main schist body throughout its entire length. Although extremely variable in size, those an inch or so across and several inches long are most common. Insensible gradations exist between single lenses and lenticular veins on the one hand, and single lenses and incipient rolls on the other. These lenses are made up almost entirely of quartz that is clear and glassy except for cloudiness made by fractures, which may be so numerous as to completely destroy the transparence or translucence in the hand specimen. Where the lenses are gold-bearing, native gold is generally the only ore mineral present. Coarse interlocking anhedral quartz individuals, that are more or less strained, incipiently microbrecciated, and shredded are revealed microscopically. The shredding or parallel texture conforms in attitude to the general schistosity of the encasing rock. Usually a selvage of brown biotite a fraction of an inch thick encloses the lens. In the case of a large lens the selvage may simply be schistose country rock in which no biotite segregation has taken place. Puckering or plicating on the ends of the schist is common wherever the end of the lens is blunt. Where it pinches out in a more gradual fashion the encasing schist closes round the end without disturbance. A frequent occurrence consists of several lenses strung out along a layer in the schist and connected by small veins or films of quartz.

Many of the lenses have an *en echelon* arrangement along the strike and along the dip of the schist. In detail each lens is conformable with the schistosity, but the next succeeding one is offset from its neighbors, so that the strike of the lens system makes a small angle with the strike of the schist. Similar relations prevail along the dip of a lens system.

Microscopic evidence shows that the vein quartz has not been derived from the immediate vicinity, because schistose quartz is in immediate contact with it and the schist has been very often itself silicified.

Lenticular veins have furnished the bulk of the gold production in the Julian-Banner district. They are most strongly developed in the Owens, Helvetia, Blue Hill, Ready Relief, North Hubbard, and Golden Chariot mines. The veins are generally a few inches wide, occasionally one to four feet, and very exceptionally over the four feet. The Stonewall Mine deposit had the largest width—12 to 20 feet—of any on record, but its true geologic character is unknown.

Excluding the Stonewall Mine, most of the gold output has come from mines where the veins worked were 1½ to 5 feet wide. In the Ready Relief group where several limbs of rolls came together, widths up to 20 feet are recorded, but this represents the combined thickness of several quartz bodies. Individual veins have no great continuity. As in lenses the next vein is separated by an interval of schist which may carry numerous quartz stringers. The veins are usually conformable in dip and strike to the encasing schist; some cut across it at small angles. They are most commonly made up of banded quartz gangue in which inconstant layers or septa of schist from a mere film to a fraction of an inch thick separate layers of glassy or translucent quartz. The boundaries between the quartz and the schist septa are both sudden and sharp, shadowy and indistinct. In the hand specimen an impression is often gained of the existence of a schist septa which proves under magnification to be merely discolored quartz. There is seldom the development of a gouge at the walls and the schist in the main adheres tightly to the quartz. Wherever gouge has been devel-

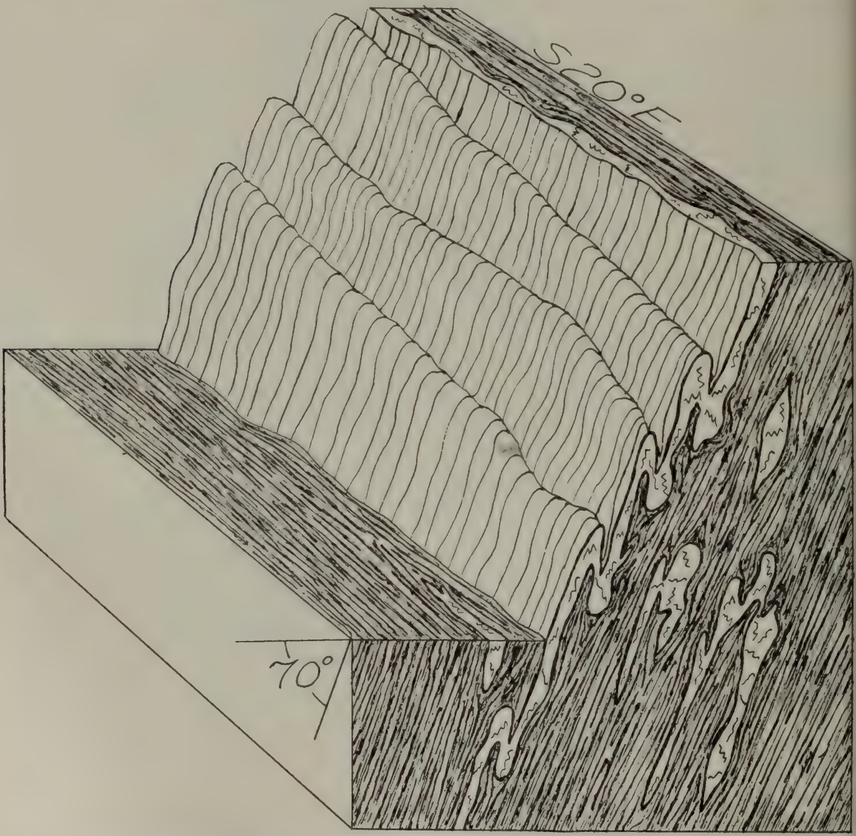


FIG. 7. Idealized diagram of a roll structure of quartz in impure quartzite and mica schist which strikes S 20°E and dips 70°NE. The roll structure as a whole dips about 60°NE. The axes of the rolls plunge northwest, toward the observer. For illustrative purposes, part of the hanging wall is not shown. The drawing is not to scale.

oped in association with a vein it appears to be later than the vein. The quartz in these veins has been apparently recrystallized since deposition, as it has a texture parallel to the walls. The boundaries as seen microscopically between gangue quartz and the schist septa are frequently irregular and suggest replacement.

The strike of the veins varies from N. 10°–20° W. in the vicinity of Banner to N. 50° W. near Julian. The dip is sharply northeast in the vicinity of Banner, southwest at varying angles on the steep slopes of the mines near the old Banner grade, and again steeply northeast in the mines on the Julian mesa. The southwest dips are due to the bending of the schist (and veins) downhill.

The broad relations of the lenticular veins of the main belt from Banner to Julian show an *en echelon* arrangement in plan. Commencing in the vicinity of the Ready Relief Mine and going northwestward a metallized belt is traversed in which the individual veins are parallel to the enclosing schist but each succeeding vein to the northwest is displaced a greater or lesser distance. Of course, overlapping along the strike occurs and the next vein to the northwest often begins before its southeast neighbor dies out.

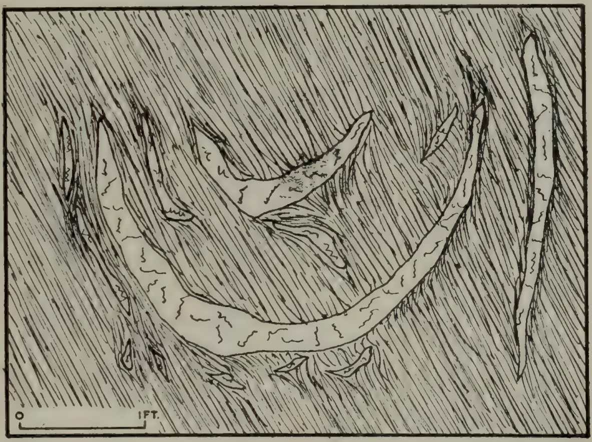


FIG 8. Section of the end of a quartz roll, where it has split into a number of stringers. North Hubbard Mine.

The most remarkable structures in the Julian region are the rolls of gangue quartz found everywhere throughout the schist belt but exceptionally well developed in the mines near Banner in the claims now included in the group from the Warlock to the South-Hubbard. The wall rocks here are dominantly highly siliceous mica schist. A silicified, well-foliated biotite-muscovite-quartz schist is a common host for this structure. In the typical case, a tabular 2–5 feet thick quartz body conformable to the schistosity, when followed down the dip merges into a trough, transecting the schistosity, which connects with another straight vein parallel to the first but offset from it. This second tabular vein or body continues upward for a short distance and gives way to a saddle that connects with a third tabular vein likewise offset and running down the dip parallel to the first two veins. Thus the dip of the flat portions may be from 70°–80° NE., while the dip of the structure as a whole may be from 40°–60° NE.

The folia of the schist wall rock are not folded around the rolls to conform with their shape, but they are disturbed somewhat at the contact. Where a roll along the strike pinches out, the schist folia merely curve and close together around the end, similar to the way they are bent around the end of a quartz lens. Likewise, in cross-section the schist folia usually bend around the curved boundary of the quartz roll.

The vein quartz adheres tightly to the schist walls and gouge has seldom been developed. Where gouge has been formed it appears to be later than the deposition of the vein quartz. The widths of the flat portions of these rolls is comparable with the widths of 'unrolled' veins, i.e., from a mere film up to several feet. Wherever they form a roll the tabular, conformable parts are often thickened and the curved transection part is commonly thickened so that combined widths up to 20 feet are attained in places. In length and depth rolls are perhaps the most persistent of any of the gangue quartz bodies. In the Hidden Treasure Mine a roll was followed continuously for 500 feet, a length probably to be regarded as near the maximum. It may be said that the horizontal extent of a good-sized (2–4 feet wide) roll may be anywhere from about twenty feet to several hundred. In vertical extent less persistence prevails. Along the dip the rolls pinch and swell very suddenly, even more so than along the strike. A roll continuous along the dip for more than 100 feet is exceptional, and dimensions of the order of tens of feet are the average. Like the lenticular veins, with which they are always associated, a roll frequently passes along the strike into a series of stringers, which retain for some distance the curved, transecting character of the main roll.

Some of the smaller rolls can be proved to merge into tabular veins along the strike. While it is true that the general tendency of the tabular parts of the rolls is to conform with the attitude of the enclosing schist, on a smaller scale many of them cut across the schistosity. The axes of the rolls generally plunge to the northwest or southeast at low angles, usually less than 25 degrees. Rolls with a northwest plunge predominate over those with a southeast one.

The predominant material in the rolls is vein quartz. Biotite, present in small, shining flakes in the quartz, has apparently been introduced or been recrystallized from local material. Varying amounts of schist are included in the quartz, as septa or residuals. Pyrrhotite and arsenopyrite constitute the principal ore minerals, with occasional specks of native gold.

The vein quartz occurs as interlocking, coarse-grained anhedra elongated roughly parallel to the axial plane of the fold. Microbrecciation is frequently seen. Quartz from rolls is found to be highly strained, but no more so than quartz from tabular veins.

The schist septa are made up principally of biotite, muscovite, magnetite, and occasionally graphite. Larger inclusions of schist contain in addition to these materials much schistose quartz. The mica schist wall rock is usually highly silicified and contains abundant pyrrhotite. The schistose quartz is not as highly strained as is the vein quartz in the nearby rolls.

Some of the rolls have been cut by radial and concentric tension fractures which are nonmetallized. Shear fractures, denoted in part by schist septa and probably inherited from the schist, are also present and these are metallized chiefly by pyrrhotite. Tiny rolls made up wholly of pyrrhotite occur. They have the same general shape as a quartz roll, but have been observed only in very small size.

The quartz rolls are believed to have been formed at the same time and by the same causes that resulted in the formation of lenticular veins and lenses. The genesis of the rolls is discussed in the following section.

Mineralogical Character.

The mineralogy of the ores is simple. Along with quartz, which is the only major introduced gangue mineral, arsenopyrite, pyrrhotite, and pyrite have been deposited in small amounts, free gold and petzite in still smaller amounts. The sulphides that occur in banded quartz deposits are apparently related to schist inclusions, or septa, in or around which they are generally clustered. Pyrite, pyrrhotite, and arsenopyrite also occur in the wall rocks. Unbanded, massive quartz commonly contains few visible sulphides. These are general relations and many unusual conditions may occur. From the little information available on the value of concentrates consisting of sulphides collected after amalgamation it is reasonably certain that the sulphides are auriferous. Many of the high-valued concentrates must owe a part of their gold content, however, to such gold-bearing minerals as petzite.

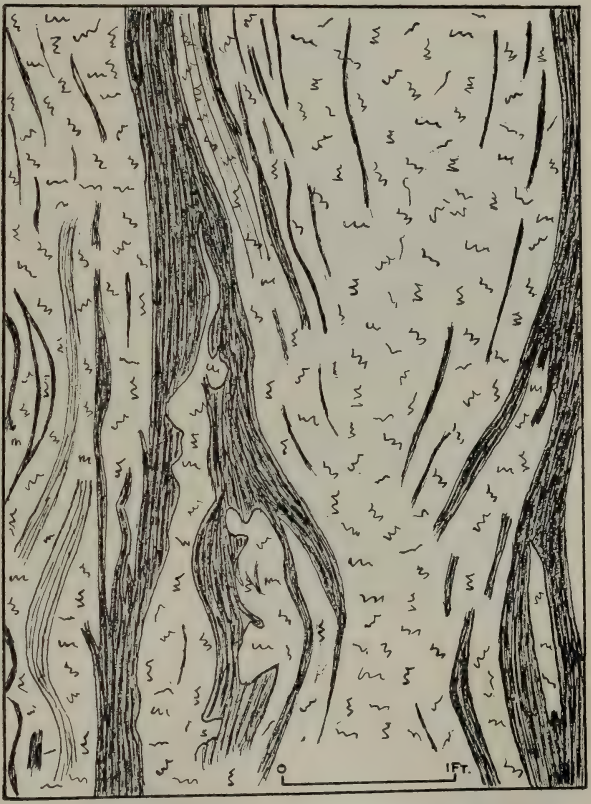
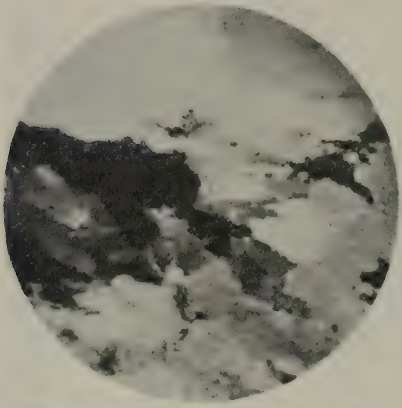


FIG. 9. Sketch of a part of the Golden Chariot vein. The lenticular nature of the quartz and the numerous inclusions of schist in the quartz are notable.

Ore Minerals—Native gold, alloyed with more or less of other metals, mostly silver, has been found in all the gold-quartz ores of the district. It occurs in masses from fine hair-like and plate-like particles of submicroscopic size up to coarse grains and nuggets measurable in fractions of inches. Native gold from the Golden Chariot Mine has a medium yellow color and is not appreciably different in depth of color from the gold of the Mother Lode system of northern California. Even though it is associated with simple sulphides, known to be active precipitants of gold, and with graphite present in the quartz veins after schist, it has not been deposited by them as large grains of native gold occur at some distance from the nearest sulphide or graphite.

Although native gold occurs chiefly in its coarse development in banded quartz ore, it is often found embedded within that ore in a layer of pure quartz with no associated minerals. This seems to indicate that part of the quartz and gold are contemporaneous. Unusual concentrations of native gold have been found associated with cleavage surfaces formed by schist septa in banded ore. In a specimen of this ore from the Golden Chariot Mine, gold is associated with brown and bleached biotite and in addition to being present in coarse irregular particles, occurs in very tiny, flat plates between cleavage surfaces of brown biotite.



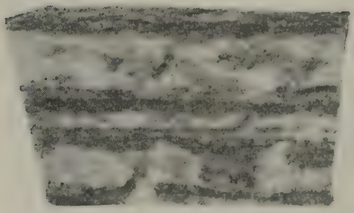


FIG. 10. (Upper) Typical banded (or ribbon) ore. The thin layers are schist septa; the white is quartz. North Hubbard Mine. One-half natural size.

FIG. 11. (Lower) Thin section of the quartz from the specimen shown in Fig. 10. The shredded and strained nature of the quartz is characteristic of much of the gold-bearing quartz. X-nicols. 13X.

The richness of the concentrates from the Golden Chariot ore and the presence of tellurium as shown by chemical tests, indicate that some of the gold occurs as a telluride. In a polished section of the ore a mineral was found which has the properties of petzite, although the criteria for the recognition of this mineral in polished section are not entirely accordant.

Pyrrhotite in granular and massive form is the commonest sulphide occurring in the ore. It is found both in the banded ore and in the wall rock. Where occurring in the banded ore it is usually related to schist inclusions. Gold occurs with it and no specimens containing visible free gold were found that did not have some pyrrhotite in them. In the polished section pyrrhotite does not show its own crystal boundaries, but has an irregular outline against the schist or quartz.

In one of the specimens examined from the North Hubbard Mine, about one-fifth of the pyrrhotite occurred in veinlets that strike off at nearly right angles to the banding in the ore; the other four-fifths is contained in stringers, elongated parallel to the banding and lying in or near schist septa. In another polished specimen from the Golden Chariot the pyrrhotite has a similar spatial relationship and is more nearly confined to the neighborhood of schist septa than is the accompanying gold.

Weathering leaches small cavities in larger grains of pyrrhotite and oxidizes the surface of grains to yield a 'peacock luster' or tarnish. This tarnish serves to help distinguish it from pyrite, moreover the pyrrhotite examined was all slightly magnetic, whereas pyrite is not.

Arsenopyrite occurs as a hypogene constituent in much of the ore. Rather large concentrations of it are found in the area in and near the Gold Cross No. 1 claim (the old Fraction claim). It is associated with visible pyrrhotite and schist septa in quartz. Arsenopyrite, which is a strongly idiomorphic mineral, is common in diamond-shaped and rectangular-outlined metacrysts that often transect the schistosity. No data are available on its gold content. Gold occurs with and without associated arsenopyrite. Weathering has frequently leached tiny cavities in the centers of arsenopyrite crystals.

Granular pyrite occurs, although not so extensively as pyrrhotite and arsenopyrite, as a constituent of the ore. It is rather common in the wall rocks, although much that in the past was thought to be pyrite is now known to be pyrrhotite. Small cubes of pyrite are found with calcite in gangue at the Golden Chariot Mine. Pyrite has also been found coating the walls of fractures in the vein quartz.

Gangue Minerals—The principal introduced gangue mineral is quartz. It is transparent or translucent in hand specimen except where highly fractured. Both the massive and banded varieties are common. The banded variety has yielded the largest amount of the gold production. Some of the quartz examined microscopically is highly fractured, some of it with two definite sets of fractures, one parallel to the banding and the other at a high angle, nearly 90°, to it. Thin slices reveal the quartz to be strained, elongated parallel to the banding or schistosity, anhedral to subhedral in outline, coarsely granular, and forming an interlocking texture described as 'shredded.' Faulting, as in the Golden Chariot Mine, has pulverized some of the quartz gangue and rendered it sugary. Much of the quartz gangue mined was coated with oxidation products and discolored. Because of the thinness of most of the veins, the quartz has not resisted erosion more than the containing rocks and does not commonly stand out against them. Euhedral quartz crystals are developed in small vugs collected from a few localities.

Associated with much of the quartz gangue is a lustrous, coarse-grained brown biotite. It occurs both in the wall rock near the quartz and along the schist septa preserved within the quartz. It is thought to have been deposited under high temperature, hydrothermal conditions.

Sericite is found rather abundantly in the veins and in the wall rock. It is considered a hydrothermal mineral, formed by reaction of solutions with the wall rock or schistose gangue minerals. Much that looks like sericite in the hand specimen is bleached biotite.

Tourmaline was found as a scanty gangue constituent. Its presence was definitely detected at the Owens, Madden, and North Hubbard mines. It does not make up any appreciable amount of the ore and is chiefly noteworthy as indicating the probable temperature of deposition of the quartz vein.

Calcite is found as stringers associated with gouge and small cubic crystals of pyrite in the Golden Chariot Mine.

The schist minerals embedded in vein quartz as residuals or septa of variable thickness are the same as those of the wall rock. They include, from place to place, biotite, muscovite (or sericite), graphite, bleached biotite likely produced by hydrothermal alteration, schistose quartz, magnetite, plagioclase, and a very scanty amount of the heavy minerals such as apatite and rutile. Graphite is noteworthy here because it frequently remains as a septa-forming mineral after all the other schistose minerals have been replaced. It has not influenced the precipitation of gold.

Supergene Minerals.—Kaolin, kalinite (or potash alum), iron oxides, and other oxidation products of the sulphides, gangue and wall rock are found near the surface in the mines. Kalinite, the birefringent potassium-aluminum sulphate, is very abundant as a supergene crust in the mine openings of the Ready Relief. Some of the kaolin from the Eagle Mine was studied and found to be an impure kaolin mixture. A dark brown, earthy, oxidation product, rich in iron, is common in some of the quartz veins. It does not contain manganese.

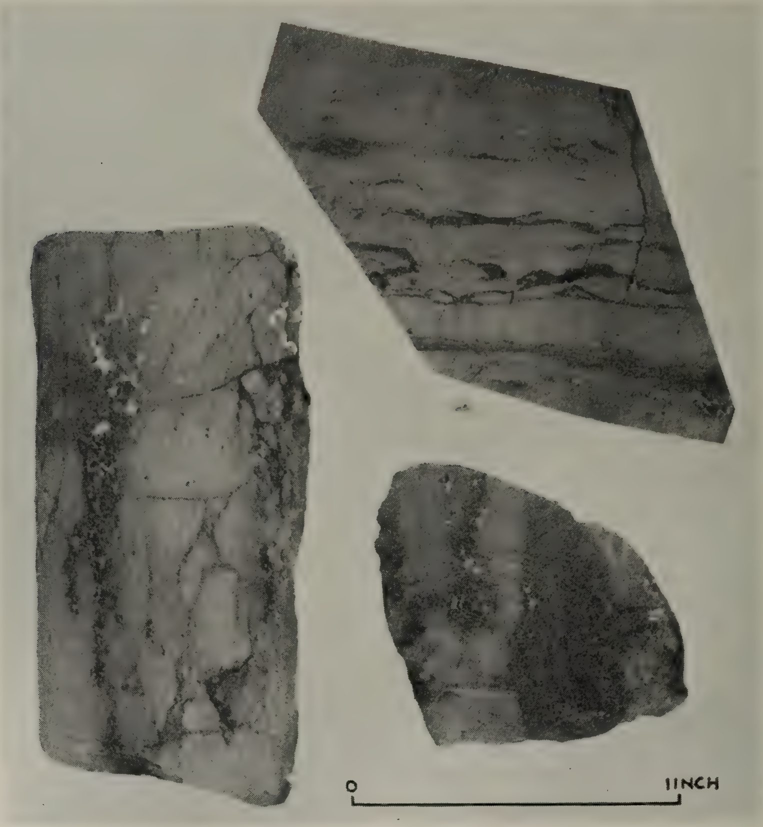


FIG. 12. Polished specimens of ore from the Banner district. In the specimen on the left the light spots are gold. Pyrrhotite in small, irregular grains is seen in the specimen on the upper right, where it is plainly associated with tiny schist septa. Arsenopyrite in somewhat rectangular grains is found, mostly in and near the schist septa, in the specimen on the lower right.

Age Relations of the Minerals.—To work out a well-founded paragenesis of the ore and gangue minerals would require many more specimens of hypogene ore than were available to the writer. Mica and tourmaline appear to be later than quartz. The simple sulphides and gold appear to be related in places to fractures in the quartz. Tiny plates of gold have been found between cleavage plates of brown biotite. Gold is also found as specks in pure quartz apparently unrelated to fractures and here seems to be contemporaneous with at least part of the quartz. On the basis of local evidence and comparison with the order of formation of minerals in similar veins the paragenesis has probably been: quartz, tourmaline, mica, pyrite, pyrrhotite, arsenopyrite, gold, and petzite.

None of the various hypotheses that have been advanced satisfactorily explain to the writer the association and distribution of the gold in the Julian deposits.

Ore-shoots.

For most of the information on ore-shoots the writer is indebted to the recollections of Mr. Al Frary, of Julian, who has operated many of the mines in the region. According to him the orebodies in the mines in the main belt—Julian to Banner—pitched north with one or two exceptions. The ore-shoots of the Golden Chariot also pitched north. The Stonewall Mine ore-shoots pitched steeply to the south.

The abrupt change in the character of the ore from rich to barren quartz is pronounced. It is reported that in following a roll-vein down the dip, a saddle would be encountered that contained ore carrying 10 oz. or more of gold per ton and in the next saddle below, in quartz of apparently the same character, no gold was found. Still farther down the dip on the same vein, quartz yielding about 4 oz. of gold was mined. A similar sudden transition along the strike also prevailed.

The size of ore-shoots on record may best be stated by giving a few examples: The Owens Mine worked an ore-shoot that had a stope length of about 400 feet and a vertical dimension of about 300 feet. The main ore-shoot in the Helvetia Mine was 150 feet in vertical length, 100 feet in stope-length, and pitched steeply south. The Stonewall Mine orebody had a stope-length in one place of 450 feet and a pitch-length of 800 feet maximum. One of the lenses or shoots of ore worked in the Golden Chariot Mine had a stope-length of 65 feet and vertical length of 185 feet. These are among the largest ore-shoots found, the majority were smaller.

No mineralogic indication for the presence of ore-shoots can yet be stated. A bluish-looking quartz is frequently mentioned in the record as being a favorable indication of gold content. It appears probable that most of the gold occurs with pyrrhotite, although ore is found in which the sum of the gold about equals the sum of the pyrrhotite. In the past, ore was prospected for by panning and assays were rarely obtained. It appears probable that much of the lower-grade ore that might have yielded a profit if it had been milled to recover the gold in the sulphides or gold compounds was thus lost.

Structural indications are a more likely source of guidance than mineralogic indications. In general the thinly banded ore has been more productive than the massive varieties. There seemed to have been a uniform supply of metallizing solutions and when this was deposited, a running foot of ore along the vein contained approximately the same amount of gold whether it was one or four feet wide.

Probable Persistence of Ore Zone in Depth.

Along a rather continuous belt or zone of ore deposition extending from the vicinity of Julian to the vicinity of Banner—a distance of about three miles—no notable change in the general character or tenor of the ore is found, despite a maximum vertical distance of approximately 1800 feet between the highest and lowest surface points in the belt. The general character of the deposits, both their structure and mineralogy, indicates that they were formed at a great depth and over a wide vertical range. If the slope of the curve of the rate of change with depth of these and similar deposits be taken as a guiding principle, it seems likely that the zone of gold deposition persists with little change in primary character to a considerable depth below the present surface.

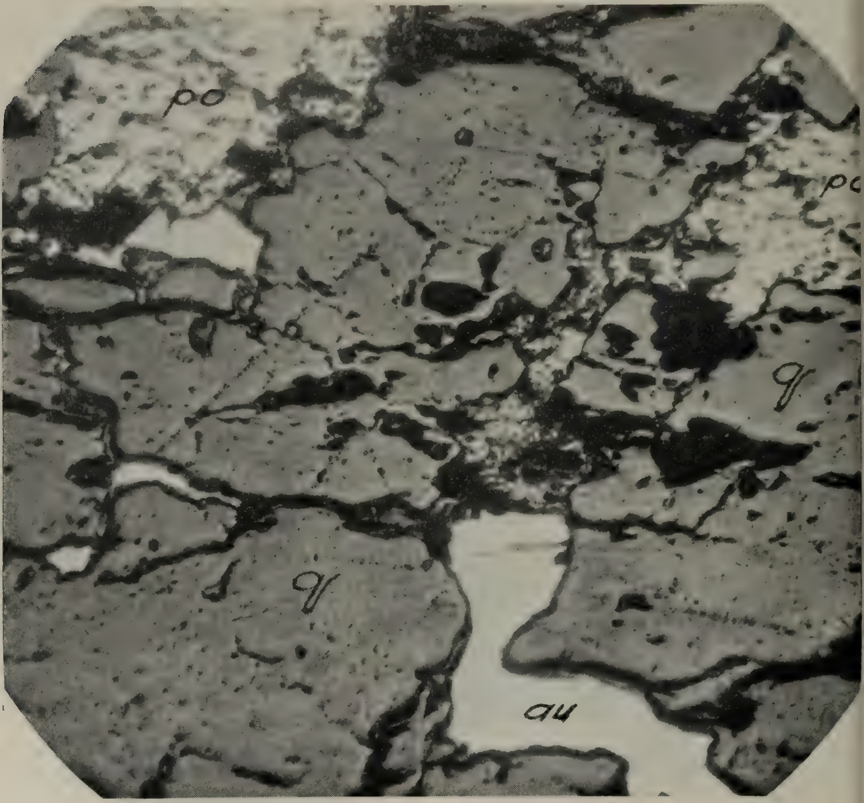


FIG. 13. Pyrrhotite (po) and gold (au) in banded quartz (q). Gold occurs as stringers and blebs, usually parallel or at high angles with the banding, which is parallel to the bottom of the photograph. Golden Chariot Mine, magnification 30 diam.

Supergene or Secondary Enrichment.

There is a decided trend in the recorded history of the camp toward an increased leanness in the ore in depth. This has been explained on the basis of secondary enrichment and it seems probable that some enrichment has taken place by removal of less valuable material, especially in the deposits on the Julian Mesa. This process may have taken place in the Stonewall, Owens, and Helvetia mines, and possibly in the uppermost zone of the Golden Chariot Mine.

It should be noted that orebodies formed by supergene enrichment involving solution and redeposition on a lower level may be expected to 'bottom' at a comparatively shallow depth, at or near the permanent ground water-level. It becomes a very practical question to determine, in so far as the evidence permits, whether the Julian gold veins have been enriched downward.

The experimental evidence tends to the conclusion that the dioxide of manganese is necessary both for the production of nascent chlorine essential to the solution of gold and for the inhibition of formation of precipitants of gold, which if formed simultaneously with the production of the soluble gold chloride would cause almost immediate redeposition of gold. Furthermore the sum of the observations on gold distribution the world over is that supergene gold—the richest gold ore—is usually found in the lower part of the oxidized zone, which was not the case in the Julian deposits. No manganese was found in the Julian ores, although much material was collected in the field that looked superficially like oxygen compounds of manganese.

Specimens of rich free-gold ore from the Ready Relief and Golden Chariot were examined in detail. These mines are associated with youthful erosional surfaces, of which the Ready Relief surface is much the younger, in comparison with the old age surface to which the mines of the Julian Mesa are related. Of the several applicable microscopic criteria to distinguish hypogene and supergene origin of ore minerals, none are at variance with the conclusion that the valuable ore minerals examined are wholly hypogene. The gold in the Golden Chariot and Ready Relief specimens is of the same generation, no gold deposition in fractures or openings associated with weathering has taken place. In the upper portions of these mines it is entirely probable that finely divided gold was formed from the breakdown of gold tellurides, but it is unlikely that this decomposition product or initially free gold has been carried downward in any large amount.

On the basis of local evidence and comparison with work done on this general problem, no significant amount of secondary or supergene enrichment is thought to have taken place in the Julian gold quartz deposits by the leaching or solution of gold from higher levels and its redeposition at lower levels.

Value of the Ore.

Based on the amount of gold per cubic foot of vein matter, the deposits have been very rich. Most of the profitable ore treated from the main belt has averaged around $50 per ton in gold (2½ oz. of fine gold). Ore yielding $100 to $500 a ton was common. It appears probable that ore occurring in this type of vein (1–1½ feet wide) carrying less than an ounce of gold per ton did not pay to mine. The profitable Stonewall Mine worked ore yielding $12–$20 per ton in relatively pure (about 900 fine) gold, but the orebody was continuous for several hundred feet along the strike and dip and was up to 20 feet wide. Much of the wall rock carries a small amount of vein quartz and sulphides and on the basis of the few assays made is thought to contain from a trace up to about 10 pennyweights of gold per ton. Much of the gold in the wall rocks is not free and can not be recovered by amalgamation and very little of it can be recovered by regrinding and reamalgamating the concentrates.

Structural Features of the Vein Openings.

At the depth at which ore deposition is presumed to have taken place, continuous well-opened fissures are only exceptionally formed. A nonhomogeneous rock like the Julian schist—which had at the time of granodiorite intrusion a well-developed schistosity—tends upon being subsequently deformed to yield along planes parallel to the schistosity. Shearing in such a rock will take place, whenever possible, by slipping along the previously developed structural planes of the schist or by rendering such planes more permeable. The portions of schist rendered more permeable may be conceived as spaces in which compression is less than nearby spaces. If shearing stress acts in such a direction that relief across the folia must be accomplished, the resultant fracture will be jagged and for any shearing stress not at right angles to the schistosity, the fracture will alternately follow and cut across the folia. Fractures much like these, except that bending is involved, have been observed on steep hillsides where the pressure of overburden has fractured impure quartzite.

In the main body of Julian schist, which is regarded as the east limb of a northwest-plunging anticline, regional folding resulted in drag-folding in some of the beds and the production of incipient fractures and spaces of less compression in others. The largest of the drag folds and the strongest and most continuous fractures pitch roughly parallel to the plunge of the anticlinal axis of the main body of schist, i.e., northwest. The major axes of most of the elliptically-shaped lenses and lenticular veins trend northwest. Pressure of the granodiorite intrusion, which has a maximum effect on the bottom of the schist wedge, probably aided in opening or enlarging spaces for ore deposition. This concept of the production of vein openings may be compared in a general way to the behavior of a book placed under compressional stress by forces acting against the ends of the leaves and under shearing stress by forces tending to cause the leaves to slip past each other.

The genesis of the quartz rolls is one of the most important problems met in the investigation. Either they have been formed by deposition of quartz in fractures that partly follow and partly transect the schistosity or they have been formed by post-mineral folding of initially tabular quartz veins. The evidence in favor of their having an origin by deposition in fractures partly following, partly transecting the schistosity appears conclusive. The schist has not been folded to conform with the rolls; in some cases the curved part of the rolls transects the schist almost at right angles for a distance of several feet.

Some of the smaller rolls can be proved to merge within a few inches along the strike into tabular veins. Although quartz from the rolls is seen microscopically to be highly strained, it is no more so than quartz from tabular veins. No good examples of rolls were seen or have been reported in the Golden Chariot Mine, where post-mineral deformation has been more severe than in any of the other mines studied. Microscopic plates of biotite jut into the quartz from a base on the wall-rock selvage; this connection would have been broken by post-mineral deformation.

The development of rolls in especial strength in the Banner district is ascribed to the stronger nature of the rocks involved and to their position nearer the middle of the anticlinal limb, the place of maximum folding adjustment.

As previously described in the report, many of the lens systems and the lenticular veins of the main ore-zone from Banner to Julian have an *en echelon* arrangement. This has been caused by the development of spaces of less compression which are individually parallel to the schistosity, but which collectively cut across the schist at a small angle.

Deposition of the Ores.

From the coarseness of the grain of the gangue quartz, the mineralogic composition, and the general geologic relations, it is inferred that the deposits were formed at considerable depth. A rough estimate would be of the order of fives of thousands of feet. From this it is likely that much of the deposits have been removed by erosion and we are here dealing with the roots that have survived.

Following Lindgren, the deposits may be classed with the type called by him hypothermal. They are believed to have been deposited under temperature conditions higher than those obtaining during the formation of the mesothermal Mother Lode vein system. The hypothermal deposits of the Southern Appalachians[14] are very similar to those of the Julian region in shape, mineralogy, and genesis. The temperature prevailing during the deposition of hypothermal deposits has been estimated to be 300°–500° C. (plus or minus) and the pressures are believed to be very high.

The solutions which deposited vein quartz and the other hypogene ore and gangue minerals, presumably came from the same magmatic source that furnished the Stonewall granodiorite. They were introduced into the schist at a high temperature and under very high pressure. It is reasonably certain that this pressure aided materially in enlarging the openings by which the solutions could gain access. The force of crystallization may also have aided in enlarging openings in which ore was deposited. In addition to these two mechanical processes it appears clear that replacement of schist by vein quartz has gone on to an important extent. Some of the bands in vein quartz that appear to be schist septa prove upon close examination to be largely residual discoloration after the schist, or to be made up almost wholly of graphite spots. In many of the cases where a definite schist septa is present, it is bordered on both sides by discolored gangue quartz, which gives the impression of the previous existence of a thicker septa, part of which has been replaced.

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[14] Graton, L. C., Gold and tin deposits of Southern Appalachians: U. S. Geol. Survey, Bull. 293, 1906.

It is not possible to make a quantitative distinction between the relative volumetric importance to be ascribed to enlargement by pressure of solutions, enlargement by force of crystallization, or replacement. It is the writer's belief that replacement and enlargement have been of about equal importance, and enlargement by force of crystallization has been of secondary importance.

Post-mineral Deformation.

The vein quartz and to some extent the encasing schist has undergone metamorphism subsequent to the time of quartz deposition. In quartz this metamorphism is shown by the layering developed (as seen microscopically) and by the platy character visible in many of the hand specimens. This structure in vein quartz is parallel to the attitude of the schistosity.

Sometime after their formation many of the quartz bodies were deformed. In the Golden Chariot Mine and in prospects along the schist-granodiorite contact, the quartz has been highly fractured, the encasing schist has been broken and crushed, and gouge has been developed in places. All of the quartz examined, irrespective of origin, has been highly strained and most of it is more or less fractured. As this fracturing probably took place after deposition of the ore minerals it can not be used as an indication of gold content.

Age of the Deposits.

The age of the deposits is thought to be upper Mesozoic, being later than the consolidation of the exposed portion of the Stonewall granodiorite. Acid pegmatites are known to cut the Cuyamaca Basic Intrusive. This may indicate that the gold-quartz deposits are later than the basic rocks.

Water Supply.

A small flow of water was encountered by some of the mines in the main belt at a depth of from 100 feet to 250 feet. Many that are bordered on the east by lower ground were almost dry at the limit reached by mining operations. In the earlier history of the camp it is probable that even a small flow of water was troublesome. Much of the water pumped from mine shafts is not potable because of a high arsenic content. A perennial supply of water has been developed by the Ready Relief group by tunneling in coarse schist in the SE. $\frac{1}{4}$ of Sec. 10, T. 13 S., R. 4 E. The spring so developed is on the south side of what is here called Ready Relief Canyon, which drains a larger area than any of the other western tributaries of Chariot Canyon. By reason of faulting, the Golden Chariot Mine makes a supply of water probably ample for milling purposes. Any plan for the construction of mills on the Julian Mesa for the treatment of gold ores must carefully consider a supply of water. The depth to water in the domestic wells that supply the town of Julian is less than 60 feet.

Placer Deposits.

Analysis of the type of storm prevailing in the region that does most of the transportation of rock debris has led to an understanding of the absence of placers in an area that has yielded rather large quantities of free, coarse gold. Most of the precipitation comes during a few winter months and occurs in such a relatively short time that stream courses which are normally dry during most of the year bear raging torrents that carry everything before them. There has hence been no opportunity either to the east or the west of the district for the steady riffling action in good-sized perennial streams on gold-bearing gravels that might cause concentration of the gold in layers. Much gold-bearing gravel has been dumped during the geologic past into the fill of San Felipe Valley and is there unrecoverable, because of the low grade of material and the lack of an adequate water-supply. The Ballena placer,[15] lying east of Ramona in T. 13 S., R. 2 E., is part of the Poway marine conglomerate of Eocene age. The gold therein probably came from the Julian region.

Practical Conclusions.

1. Discoveries of many bodies of extremely rich oxidized ore occurring near or at the surface are not expected in the future. It may be remembered, nevertheless, that almost twenty years after the initial discoveries in the early seventies, rich masses of ore, such as those of the Ranchita, Gold Queen, and others, were found. Even after the long period of time during which the Julian gold deposits have been known, it can not be said that all of the favorable ground has been intelligently prospected.
2. Areas depicted on the map as representing schistose rocks should be well prospected. The ordinary method of prospecting by panning a stream course that heads in such rocks is worth while, but absence of colors should not be taken as indicating absence of lode deposits.
3. The ore zone may be expected to extend in depth considerably beyond any point attained by previous mining operations in the district.
4. The quartz bodies do not occupy fissures in the usual sense and well-defined gouge and fracture walls are generally absent. Thorough exploration of the ground on both sides of a vein or series of veins is necessary to verify the lateral extent of the metallized zone.
5. The mineralogic indications are (1) shiny, sometimes bluish, often transparent or translucent quartz, which may, however, be rendered opaque and sugary by fracturing, and (2) visible sulphides and free gold.
6. Ores mined in the future will probably contain less free gold and more auriferous sulphides and gold compounds than was the case during the previous history of the camp. Such ore can not be treated economically by amalgamation only. Everything considered, flotation in some form offers the best possibility for a high recovery of gold.
7. Assays must be run to determine the gold content of the quartz; panning is a valuable, although often misleading, guide.

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[15] Merrill, F. J. H., Geology and mineral resources of San Diego and Imperial Counties: State Mineralogist's Rept. XIV, 1914.

8. Metallurgical treatment of unoxidized ores must take into account the known occurrence of gold in tiny plates between leaves of biotite, and of free gold, gold compounds, and auriferous sulphides in intimate association with tough, elastic schistose materials.

9. The richness of some of the ore makes necessary careful mining extraction to prevent losses. Sacking in stopes under supervision may be advisable.

10. The problem of water supply should be carefully considered before erecting reduction works.

OTHER MINERAL DEPOSITS

Nickel, Copper, and Iron.

Associated with the gabbroic rocks of the Cuyamaca massif are small deposits of nickel and copper-bearing pyrrhotite. Wherever they have been exposed on the surface, weathering has produced a gossan made up principally of iron oxide. The primary ore consists largely of pyrrhotite with lesser but megascopically visible quantities of chalcopyrite and minor amounts of nickel-bearing minerals, pentlandite $(Fe,Ni)S$; violarite $(Ni,Fe)_3S_4$; and possibly polydymite, Ni_3S_4. The discrimination of the nickel minerals is difficult, even in polished sections of the ore.

These deposits represent syngenetic magmatic concentrations of sulphides that have solidified at about the same time as the basic rocks that enclose them.

Various attempts have been made to exploit the deposits; only one, the Friday Mine orebody, has been worked to any extent. Several shallow pits have been dug in gossans at various places near the Friday Mine.

Lithia.

No lithia-bearing pegmatites have been found in the region mapped. One small lithia-bearing pegmatite deposit occurs on the southwest slope of Granite Mountain in Sec. 18, T. 13 S., R. 5 E., in what has been called the Royal Mine.

Graphite.

Graphite is found in small quantities in much of the Julian schist and hence is present in some of the schist septa in the gold-bearing quartz. The amount found in the schist in the region mapped is so small that it probably will never constitute a commercial source of the mineral. In Mason Valley, southeast of the area, graphite schist has been reported and a specimen of this material shows graphite to be present in considerable amount. In prospecting for this mineral it is well to remember that because of its opaque nature, graphite appears to make up a higher percentage of the mass than is actually the case.

Hot Springs.

Hot springs are found along the trace of the Elsinore fault zone in Rodriquez Canyon, at the eastern edge of the mapped area.

GEOLOGIC BRANCH

WALTER W. BRADLEY, STATE MINERALOGIST.

PLATE IV.

OLAF P. JENKINS, CHIEF GEOLOGIST.

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CALIFORNIA STATE DIVISION OF MINES
WALTER W. BRADLEY, STATE MINERALOGIST

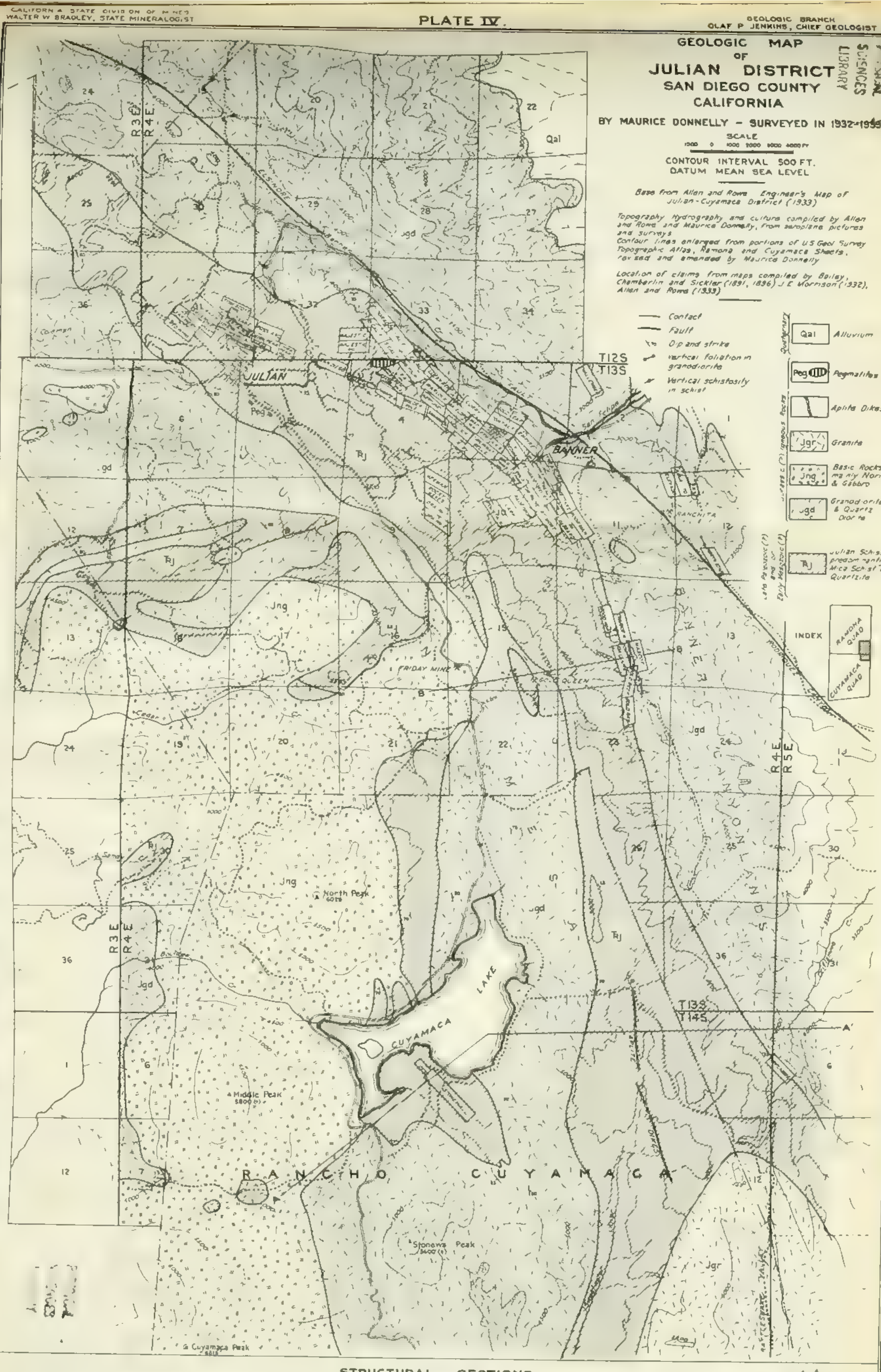
PLATE IV.

GEOLOGIC BRANCH
OLAF P. JENKINS, CHIEF GEOLOGIST

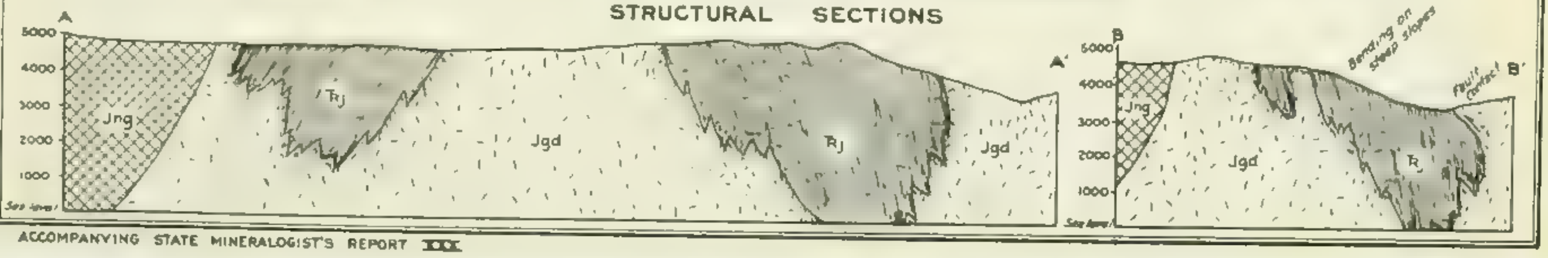
P[illegible] SCIENCES LIBRARY

GEOLOGIC MAP OF JULIAN DISTRICT SAN DIEGO COUNTY CALIFORNIA

BY MAURICE DONNELLY – SURVEYED IN 1932-1933


SCALE
1000 0 1000 2000 3000 4000 FT
CONTOUR INTERVAL 500 FT.
DATUM MEAN SEA LEVEL
Base from Allen and Rowe Engineer's Map of Julian-Cuyamaca District (1933)
Topography, Hydrography and culture compiled by Allen and Rowe and Maurice Donnelly, from aeroplane pictures and surveys
Contour lines enlarged from portions of U.S. Geol. Survey Topographic Atlas, Ramona and Cuyamaca Sheets, revised and amended by Maurice Donnelly
Location of claims from maps compiled by Bailey, Chamberlin and Sickler (1891, 1896) J. E. Morrison (1932), Allen and Rowe (1933)
Contact
Fault
Dip and strike
Vertical foliation in granodiorite
Vertical schistosity in schist
Quaternary
Qal Alluvium
Peg Pegmatites
Aplite Dikes
Jgr Granite
Jng Basic Rocks – mainly Norite & Gabbro
Jgd Granodiorite & Quartz Diorite
Jurassic (?) Igneous Rocks
Late Paleozoic (?) and or Early Mesozoic (?)
TRj Julian Schist predominantly Mica Schist & Quartzite
INDEX
RAMONA QUAD
CUYAMACA QUAD
JULIAN
BANNER
RANCHITA
FRIDAY MINE
North Peak
Middle Peak
Stonewall Peak
Cuyamaca Peak
CUYAMACA LAKE
RANCHO CUYAMACA
T12S
T13S
T14S
R3E
R4E
R5E
Qal
Jgd
Jng
Jgr
TRj
A
A'
B
B'

STRUCTURAL SECTIONS


A
A'
B
B'
5000
4000
3000
2000
1000
Sea level
Jng
TRj
Jgd
Bending on steep slopes
Fault contact

GEOLOGY AND MINERAL DEPOSITS OF THE ELIZABETH LAKE QUADRANGLE, CALIFORNIA *

By EDWARD C. SIMPSON **

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* Abridged from a thesis submitted to the Department of Geology, University of California, Berkeley. Manuscript received October, 1932.

** Temporary field geologist, California State Division of Mines.

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ABSTRACT

The area described is known as the Elizabeth Lake quadrangle whose center is located 35 miles north of Los Angeles. It embraces a large triangular segment of the San Gabriel Mountains[1] north of Mount Baldy, a smaller segment of the Tehachapi Mountains, and a part of the Mojave desert which covers two-thirds of the area mapped.

Metamorphic rocks occur in both mountainous regions. In the Tehachapi Mountains these rocks, present as huge inclusions in the granite, are composed chiefly of crystalline limestone, mica, and quartz-mica schists, quartzite and slate, metamorphosed andesite, dacite flows and tuffs. This group of rocks, herein named the Bean Canyon series, is more than a mile thick and is probably of Triassic age.

In the San Gabriel Mountains, the Pelona Schist series makes up the greater part of the Sierra Pelona, a range that trends for 20 miles across the southern part of the quadrangle. The schists are probably of Archean age and are about a mile and a half thick.

Granitic rocks are exposed over a large part of the area, and, with the metamorphic rocks, form the basement upon which the Tertiary and Quaternary sediments were deposited. Quartz monzonite and quartz diorite make up the bulk of the San Gabriel and Tehachapi Mountains and crop out in many places on the desert plain. They are correlated with the Sierra Nevada granitic rocks of late Jurassic or early Cretaceous age.

The oldest unmetamorphosed sedimentary rocks of the area are marine sediments of early Eocene age, the Martinez formation. They are a series of alternating beds of sandstone and shale aggregating some 7500 feet in thickness.

The younger sedimentary rocks are of subaerial and lacustral origin. They comprise the Escondido and Rosamond formations of probably middle and upper Miocene age, and also extensive areas of Quaternary alluvium.

The rocks of this region have been greatly faulted and but little folded. The chief geographical units of the region are delimited by faults. The San Andreas rift is a most striking structure. It defines the desert boundary of the San Gabriel Mountains and courses across the southern part of the quadrangle, marked by long, narrow, down-faulted blocks, a well-defined rift valley, a hillocky valley floor and ponded drainage. The Garlock fault and its branch fault, the Oak Creek Canyon fault, bound the Tehachapi Mountains on the southeast and govern the principal planes along which the mountains have been elevated. The Rosamond fault trends eastward across the northern

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[1] The San Gabriel Mountains are considered in this paper to extend northward, meeting the southern end of the Tehachapi Mountains at the head of Antelope Valley.

part of the quadrangle, separating the Rosamond Hills region from Antelope Valley. The Bouquet-Bee canyons fault system and the Pelona fault bound the Sierra Pelona on the north and south, respectively, and are the planes along which it has risen.

The most valuable mineral resources of this quadrangle are gold, magnesite, feldspar, building stone, and road material, all of which have been mined at times. Artesian water is utilized extensively in some of the alluvial areas.

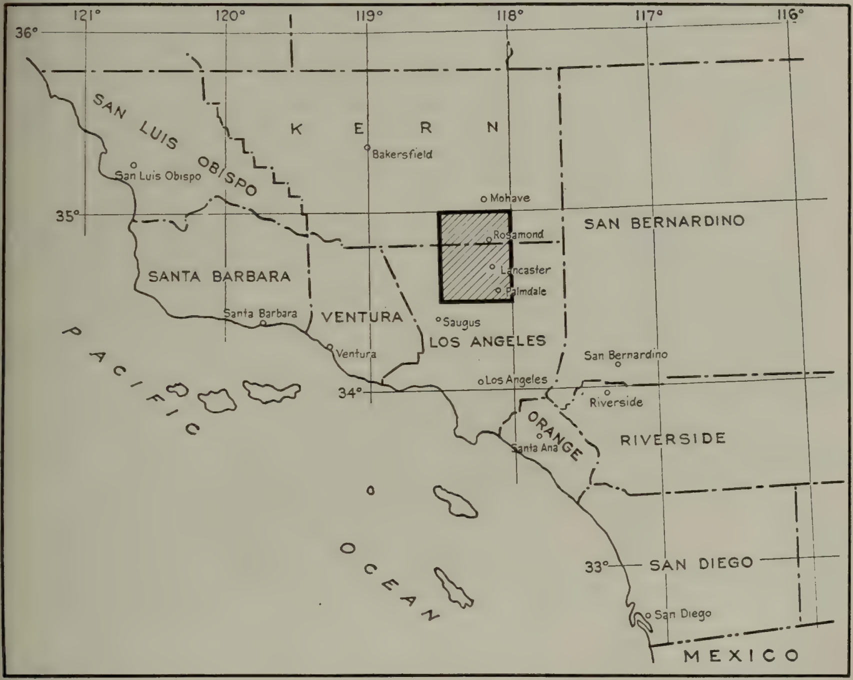
121°
120°
119°
118°
117°
116°
36°
35°
34°
33°
SAN LUIS OBISPO
KERN
Bakersfield
San Luis Obispo
Mohave
SAN BERNARDINO
Rosamond
Lancaster
Palmdale
SANTA BARBARA
Santa Barbara
VENTURA
Saugus
LOS ANGELES
Ventura
San Bernardino
Los Angeles
Riverside
ORANGE
Santa Ana
RIVERSIDE
PACIFIC
OCEAN
SAN DIEGO
San Diego
MEXICO

Fig. 1. Index map, showing area covered by the Elizabeth Lake quadrangle.

INTRODUCTION

Location.

The area described in the following report lies about 35 miles north of Los Angeles and is known as the Elizabeth Lake quadrangle. It is bounded by meridians 118° and 118° 30′ and parallels 34° 30′ and 35°. Its northern boundary passes 4 miles south of Mojave. The area covers parts of Kern and Los Angeles counties and includes a portion of the San Gabriel and Tehachapi Mountains and the intervening westerly part of the Mojave Desert known as Antelope Valley.

The main line of the Southern Pacific Railroad passes through the center of the quadrangle with stations at Palmdale, Lancaster and Rosamond. It is paralleled by the State highway which runs from Bakersfield to Los Angeles by way of Tehachapi. Other highways enter the quadrangle from Saugus by way of Bouquet Canyon, San Francisquito Canyon, and Elizabeth Lake Canyon.

The Rosamond Hills occur in the northern part of the quadrangle while to the east is an open desert including an enclosed basin, the

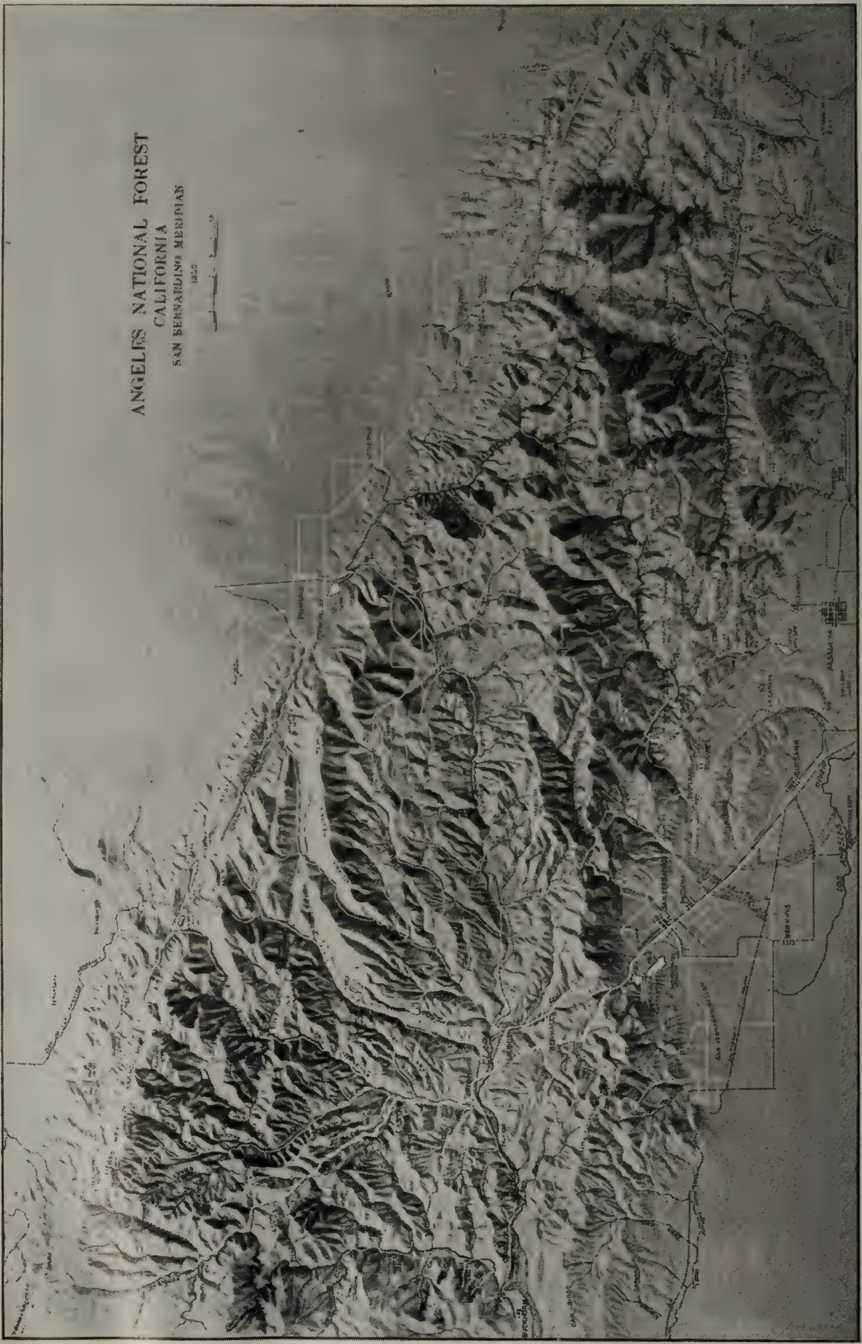
ANGELES NATIONAL FOREST
CALIFORNIA
SAN BERNARDINO MERIDIAN

FIG. 2. Relief model by H. A. Sedelmeyer of the Los Angeles National forest, showing clearly the trace of the San Andreas fault

lowest part of which is occupied by a large playa, known as Rosamond Dry Lake. Though it receives drainage from the Tehachapi and San Gabriel Mountains, this desert area has no perennial streams or lakes. Except after infrequent torrential rains, the ephemeral streams sink into the desert alluvium at a short distance from the mountain front. A few small hills, Antelope Buttes, Rogers Buttes, and Quartz Hill, rise above the valley floor.

North of Antelope Valley the Rosamond Hills rise island-like out of the desert plain. Since they are composed of lava, strongly cemented sandstones, and conglomerates, and are very resistant to desert weathering, they exhibit rugged contours and steep slopes. The hills of granitic rocks, on the other hand, are less resistant, and consequently have been reduced by weathering to low knolls and ridges covered almost up to their crests with detritus.

The Tehachapi Mountains merge northward with the Sierra Nevada, and westward with the San Gabriel Range. They are rugged and rise sharply from the desert floor to an altitude of 8000 feet. The range is flanked on the southeast by a broad alluvial apron that rises high up on the mountain side to a zone some 1700 feet above the desert floor. Its upper part is a veritable 'badlands' because of the very numerous steep-sided canyons and gullies that have been cut into it. The prominence of the Tehachapi escarpment here is due mainly to elevation by Quaternary faulting. The stream beds of the canyons are dry in summer except where occasional springs are able to maintain a small stream for a few hundred yards. However, after a heavy storm the canyons are filled with raging torrents that carry an immense amount of detritus far out on the alluvial fan. A scant cover of sage, greasewood, bunchgrass, and juniper grows on the lower slope of the mountains and on the fan wherever it can gain a hold. In the broad dry washes is a sprinkling of yucca ('Joshua') trees. The land is of little use for cattle raising or agriculture. Where land is cleared the wind seizes upon it and quickly sweeps away every bit of soil. In the upper reaches of the mountains, however, where there is a fair amount of forage and water, there is a little cattle and sheep raising.

The southwest corner of the quadrangle includes a triangular segment of the San Gabriel Mountains about 250 square miles in area. It includes Sawmill Mountain, north and west of Elizabeth Lake, the Sierra Pelona, an east-west range which bounds it on the south, and Portal Ridge, which forms the southwest wall of Antelope Valley. It is a region of moderate relief with gentle slopes, rounded knolls and broad flats. The ridges and crests range from 4500 to 5000 feet in elevation, 2500 feet above the desert floor. Except in the canyon bottoms, the bedrock is deeply weathered. Broad alluviated valleys, remnants of an older cycle of erosion, are deeply incised by V-shaped canyons. In places, an old alluvium, 20 to 150 feet thick, covers the flat ridges 500 and 600 feet above the canyon bottoms. The watershed trends roughly N. 65° W., parallel to Portal Ridge and 3 to 5 miles distant from it. In contrast to the short desert slope, the Pacific slope is 15 to 20 miles long. Pine Canyon, Leona Valley, and Anaverde Valley are adjoining valleys that trend about N. 65° W., controlled by and lying within the San Andreas fault system. They are characterized in places by abnormally steep valley walls, hillocky valley floors, long narrow median ridges, and blocked drainage. Leona and Anaverde

Valleys are fertile and sheltered, devoted to agriculture and cattle raising.

Climate and Vegetation.

The climate of the region is arid, the seasonal rainfall ranging from six inches in the lower parts of the quadrangle to some twelve inches in the higher altitudes. Summer temperatures of more than 100° F. are usual, their severity mitigated by the dryness of the atmosphere. Winter temperatures range between 10° and 65° F. A powerful west wind sweeps unchecked over the region most of the year.

Low shrubs, such as sagebrush and creosote, characterize the uncultivated parts of the desert, while giant yuccas or 'Joshua trees' grow in parts of the region above 2300 feet, where the watertable is not too close to the surface. Junipers are abundant on the mountain slopes and the alluvial fans. Black willow, mesquite, and cottonwood are found in the region about springs and along stream courses.

Acknowledgments.

The writer thanks all those who gave of their time and knowledge in forwarding this investigation. He owes a special debt to Professor Carlton D. Hulin of the University of California for helpful criticism, to Professor Hubert G. Schenck of Stanford University for examination of fossil material, and to Mr. Walter W. Bradley, State Mineralogist, at whose invitation this study was begun.

The field study was carried on during the summers of 1929, 1930, and 1931.

DESCRIPTIVE GEOLOGY

The rocks exposed in this quadrangle range in age from pre-Cambrian to Recent. They include metamorphic and granitic rocks, marine and terrestrial sediments, and lavas.

Metamorphic rocks of the Pelona schist series are the principal rocks of the Sierra Pelona, a low mountain range that trends eastward across the southern part of the quadrangle. Schists, slate and crystalline limestone of the Bean Canyon series compose great roof-pedants in the granitic rocks of the Tehachapi Mountains.

Granitic rocks are exposed in a large part of the region and are believed to underlie the other rocks of much of the area. They compose the bulk of the Tehachapi and San Gabriel Mountains, are exposed in much of the Rosamond Hills region, and crop out in a few places in Antelope Valley. Quartz monzonite and quartz diorite are the prevailing types.

Thick deposits of marine sandstones and shales of Eocene age are present in a small area in the western part of the quadrangle.

Coarse continental sediments of Miocene age exist in great thickness in much of the area. In the Rosamond Hills they include much acid and basic volcanic rocks, with acid types predominant; while in the southern and western parts of the area, basic types prevail.

Alluvium is several thousand feet deep in parts of Antelope Valley. Besides the recent alluvium there are remnants of an older alluvium that exists as patches on high terraces in the southwestern part of the quadrangle, and as elevated and dissected alluvial fans of he Tehachapi and San Gabriel Mountains.

The rocks of the region have been greatly faulted and but little folded. The principal faults are surfaces of great displacement and constitute the chief structural features of the area. The principal east-west faults are the Garlock fault, which bounds the southern base of he Tehachapi Mountains; the Rosamond fault, which forms the southern boundary of the Rosamond Hills; and the Bouquet-Bee Canyon fault system and the Pelona fault, which bound the Sierra Pelona on the north and south, respectively. The greatest of all is the San Andreas, a fault of great lateral displacement, which trends northwest offsetting many of the east-west faults.

Age determinations of the rocks have necessarily been made on the basis of lithology and stratigraphic position, as the rocks of the region are almost barren of determinable fossils.

The section of stratified rocks has an aggregate thickness of about 33,000 feet. It is summarized in the following table.

STRATIGRAPHIC COLUMN OF THE ELIZABETH LAKE QUADRANGLE

	Thickness in feet
RECENT	
Alluvium	
Unconsolidated silt, sand, gravel, and boulders.	
PLEISTOCENE	
Older alluvium	50–2000
Bench gravels, sands and silts; uplifted and dissected alluvial fans.	
MIOCENE	
Rosamond formation	1600–3400
Continental arkosic sands, conglomerates, boulder beds, chert, limestone, tuffs, breccias, flows and intrusive bodies of dacite and basalt.	
Escondido formation	8400
Continental arkosic sands, conglomerates, shales, basaltic and dacitic lava flows.	
EOCENE	
Martinez formation	7500
Alternating beds of marine sandstones and shales, with occasional thin beds of conglomerate.	
TRIASSIC (?)	
Bean Canyon formation	5000
Slate, quartzite, marble, mica schist, amphibole schist, andalusite-cordierite schist, meta-andesite and meta-dacite.	
PRE-CAMBRIAN	
Pelona schist formation	7500
Mica schist, hornblende schist, greenstone schist, quartzite, and crystalline limestone.	
Total maximum thickness	31,800

Pelona Schist Series.

Distribution and General Features.

The Pelona schist series is exposed over some 130 square miles in the southern part of the quadrangle. The rocks of this series compose the Sierra Pelona, a low mountain range that extends westward for 20 miles across the quadrangle, and also make up a 12-mile strip of Portal Ridge which adjoins the Sierra Pelona on the east. Quartz Hill, in Antelope Valley, two miles east of Portal Ridge, obviously represents a continuation of the schists of Portal Ridge and indicates the probable nature of the bed-rock of this part of the valley.

The Pelona schist series is a group of metamorphosed sedimentary rocks, lavas, and tuffs, consisting for the most part of greenstone schist, amphibole schist, mica schist, quartzite, and limestone, whose total exposed thickness is estimated to be more than 7500 feet. It is apparently a conformable sequence wherein the bedding planes are parallel to the schistosity throughout. The rocks range from medium to fine-grained and are all plainly schistose. They have been thrown into broad open folds, and in places exhibit much fissuring and faulting. Topographically, the metamorphic terrain is expressed by broad, gently-rounded ridges which trend parallel to the bedding planes. The schists weather to shades of red: the mica schist to light rust-red, the greenstone to dark red, and, in sheltered places, to bright maroon. In the somewhat scarce fresh exposures, the mica schist is light gray; and the amphibole schist ranges from slate-gray and pistachio-green to dark-green.

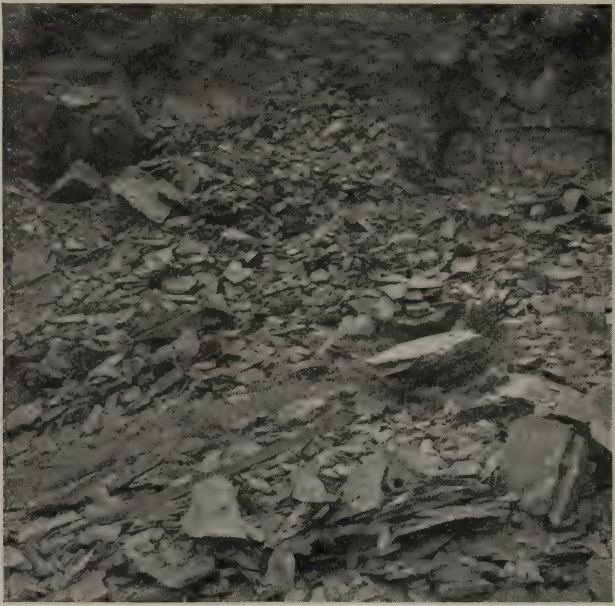

FIG. 3. Pelona schist flagstones. Old Mission quarry, Bouquet Canyon.

The Sierra Pelona is a fault block range bounded on the north by the Bouquet-Bee canyon fault system, on the east by the San Andreas fault, and on the south and west by the Pelona fault. Internally, the block is greatly broken by a multitude of smaller faults. Here the general trend of the schists is east-west changing to northeast in the western part of the range, where they form an anticline. In the eastern part of the range the Pelona fault cuts off the southern limb of the anticline and the exposed rocks are all dipping north.

A cross-section of the eastern part of the range, starting from Sec. 7, T. 5 N., R. 13 W., on the south side, revealed the following facts. For several thousand feet north of the Pelona fault, the schist is so broken by a net-work of faults of apparently small displacement that no estimate of the thickness or sequence of the schists can be made. The rock of the lower part of the series is a thin-bedded gray, medium-grained mica schist, which weathers like granite to a dull reddish-brown sand. Infrequent thin beds of crystalline limestone and quartz-mica schist are included. This rock forms the south slope of the Sierra Pelona and has an estimated thickness of 5500 feet. The transition to the upper part of the series is marked by more and more frequent interruptions of the mica schist sequence by thin beds of quartzite, limestone, and greenstone schist, until these rocks are the predominant types. Of these the greenstone schist is the most abundant type, having an aggregate thickness of some 700 feet. It forms the north slope of Sierra Pelona along the line of the section, where it weathers to form a bright maroon soil. Individual beds range in thickness from 3 to 20 feet and are distinguished by slight lithological differences. Thin beds of quartzite, quartz-mica schist, and mica-schist are intercalated with the greenstone schist and toward the top of the series gradually replace it. The upper part of the series has an estimated thickness of 2000 feet. Portal Ridge and Quartz Hill are composed of the same types of rock and are considered to be eastward extensions of the Sierra Pelona.

Mica Schist.

Mica schist is the most abundant material of the series, making up most of its lower part and some of its upper. In composition it is like that of a granite gneiss, being composed chiefly of albite feldspar with subordinate quartz and biotite. Specimens from the top and bottom of the series closely resemble each other, both in appearance and composition. It is fairly fine-grained; individual feldspar and mica grains can just be made out with the hand lens.

The intercalations of beds of crystalline limestone, quartz-mica schist, and quartzite in the mica schist series indicate the probable detrital origin of the whole series. Although it is possible that the mica schist represents a metamorphosed sequence of acid volcanic rocks, it is much more likely to represent a metamorphosed sequence of arkosic sands.

Greenstone Schist.

In the typical schist, conspicuous grains of white albite feldspar ranging in size from 1 mm. to 1 cm. are set in a ground-mass of fine-grained dark-green minerals. These are of epidote, green hornblende, and chlorite.

The greenstone schists have the chemical nature of a basic igneous rock and probably represent a series of basaltic lava flows with associated tuffs.

Quartzite.

Quartzite is always thin-bedded in this series, occurs sparingly in the lower part and is only little more prominent in the upper part. Associated with the greenstone schist are interbedded much thinner layers of quartz-mica schist, that closely resemble alternating beds of chert and shale. The quartzite is usually fine-grained and distinctly schistose, due to flattening of the quartz grains in the plane of schistosity.

Talc-actinolite Dikes and Sills.

Talc bodies, a few inches to 20 feet thick, occur in the Pelona schist as sills and dikes. They are apple-green in color, and in many places seem free of impurities. The largest of the dikes examined by the writer is 20 feet wide, strikes for a half mile across the southwest corner of Sec. 7, T. 5 N., R. 13 W., and dips steeply to the northwest. A talc sill 25 feet thick is exposed in a road-cut in Bouquet Canyon in Sec. 1, T. 5 N., R. 15 W. Actinolite is usually associated with the talc, frequently as ''nests'' or border zones; and in places the talc passes into actinolite along the strike of the dikes or sills. These bodies were originally dikes and sills of peridotite, composed of silicates of magnesium, calcium, and iron, that have been changed to their present state by hydrothermal metamorphism.

Quartz Veins.

Veins of pure white granulated quartz, ranging in width from a few inches to 100 feet, and characterized by abrupt swellings and pinchings, are of common occurrence—cutting the Pelona schist series. Some of these bodies are roughly circular in plan. The most conspicuous of the 'quartz blow-outs,' as they are called in the region, constitutes the backbone of Quartz Hill, six miles southwest of Lancaster. Similar quartz veins are of common occurrence in the adjoining granitic rocks and are considered to be genetically related to them.

Nature of Metamorphic Action.

There is no apparent difference in the degree of metamorphism from the top to the bottom of the Pelona schist series. There are no relict minerals, the rocks are completely recrystallized, and schistose structure characterizes the whole series. These features, together with the fact that the minerals of the rocks consist of soda-rich plagioclase, epidote, zoisite, muscovite, actinolite, and chlorite, indicate metamorphism of the mesozone, or the zone in the earth's crust of moderately high temperature.

Age and Correlation.

That the Pelona schists were probably metamorphosed in pre-Cambrian time, not improbably in the Archean era, is indicated by the following facts: the Lower Cambrian rocks of the Inyo Range, 100 miles to the north; the Paleozoic rocks of the nearby Randsburg quadrangle; and the Lower Cambrian rocks of the eastern Mojave Desert near Cadiz are either unmetamorphosed, or have been only locally metamorphosed by igneous intrusions.[1] In the lower part of the Paleozoic section in the Randsburg quadrangle, Hulin found detrital fragments of the Rand schist, correlative of the Pelona schist series.[2]

The Rand schists which outcrop over a large area in the Randsburg quadrangle are the only known correlatives of the Pelona schist series. The writer has examined the Rand schists in the field and in the laboratory and found them to be identical in lithology and structure with the Pelona schist series.

Pre-Cretaceous Metamorphic Rocks.

Bean Canyon Series.

The Bean Canyon series consists of schist, slate, and crystalline limestone which occur as roof-pendants in the granitic rocks of the Tehachapi Mountains. Besides many large roof-pendants, myriads of small fragments of members of this series are scattered throughout the granitic rocks. The largest of the roof-pendants range in length from one to three miles, and in width from one-quarter to one mile. They form a belt that trends northeast by east, parallel to the mountain front and to the strike of the schists. This belt stands out as a prominent southeast scarp of the Tehachapi Mountains because the schists and, more especially, the crystalline limestone, are more resistant to weathering and erosion than the surrounding granitic rocks. It continues southwest at least as far as the junction of the Tehachapi Mountains and the San Gabriel Mountains, and north as far as the Tehachapi Mountains extend, and into the Sierra Nevada. To the northwest, belts of similar schists and crystalline limestone are found at intervals across the range to the San Joaquin Valley.

The Bean Canyon series has been metamorphosed largely through the influence of batholithic intrusion. Consequently, the effects are local and gradational, ranging from slightly metamorphosed slates farthest from the igneous contact to completely recrystallized schist and hornfels closer to the contact. The rocks were apparently sharply folded prior to the batholithic intrusion. The folding is apparent in the broad schist belt that forms the Tehachapi Mountain front but also is seen in many of the smaller masses nearer the head of Cottonwood Creek. The foliation is parallel to the bedding throughout the series.

The formation is named from Bean Canyon located in the northwest corner of the quadrangle where an excellent section of the series is exposed. Though a wider belt of schists is exposed in Bean Canyon than in the much larger roof-pendants to the west, the latter contain some 1500 feet of limestone compared to 200 feet of it in Bean Canyon. The rocks of Bean Canyon are typical of those occurring throughout this schist belt. Cutting a roof-pendant one mile wide, Bean Canyon exposes a conformable series of schists, marbles, and slates which dip northwest at angles ranging from 60° to 85°. The top of the exposed section is in fault contact with quartz-monzonite, the bottom is in intrusive contact with quartz-monzonite. A section of the metamorphic rocks in Bean Canyon in the order of the youngest to oldest is given below:

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[1] Knopf, Adolph, and Kirk, Edwin. A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, Cal.: U. S. Geol. Survey Prof. Paper 110, 1918.

Clark, C. W., Lower and Middle Cambrian formations of the Mohave desert: Calif. Univ. Publ. Dept. Geol., Bull. 13, p. 3, 1921.

[2] Hulin, C. D., Geology and ore deposits of the Randsburg quadrangle, Calif.: California State Mining Bureau Bull. 93, 1925.

Member	Description	Thickness, feet
1.	Graphitic slates, very much broken against the fault	170
2.	Thin-bedded graphitic slates with subordinate thin beds of quartz-muscovite schist and quartzite	345
3.	Gray porphyritic meta-andesite and meta-dacite flows	310
4.	Biotite-andalusite schist, thin-bedded	165
5.	Coarsely crystalline white marble	80
6.	Biotite-plagioclase schist. Contains many thin lenses of vein quartz parallel to the schistosity	125
7.	Quartz-biotite schist, thin-bedded, with several intercalated beds of quartzite	430
8.	Thin-bedded quartz-biotite schists, quartz-biotite-andalusite schists, paper-thin flexible quartz-muscovite schists. A thin sill of pyroxenite, half altered to serpentine lies within the schists	170
9.	Coarsely crystalline thick-bedded white marble	20
10.	Black thin-bedded biotite-plagioclase schist, and hornblende-plagioclase schist	425
11.	Black serpentine intruded parallel to the bedding	150
12.	Biotite-hornblende-plagioclase schist and hornblende-plagioclase schist	460
13.	Thin-bedded biotite-andalusite-cordierite schist with frequent intercalations of quartzite	195
14.	Coarse-grained thin-bedded white marble	145
15.	Thin-bedded biotite-andalusite-cordierite schist, paper-thin quartz-biotite schist, hornblende-diopside-plagioclase hornfels, coarse-grained massive white marble, and biotite-andalusite-cordierite hornfels, intruded by granite dikes	610
	Total thickness	3,800

These rocks are the metamorphic equivalent of a series of shales, sandstones, limestones, tuffs, and lava flows, waterlaid sediments for the most part, and probably marine judging from the large amount of limestone. The original thin-bedded structure of the series is very distinctly preserved, even the fine cross-bedding of one of the quartzite members is discernible. Much of the series represents original clayey sediments which are now converted to slates or to schists containing abundant highly aluminous minerals such as andalusite, cordierite, and sillimanite. Original sandstone is represented by quartz-mica schist and quartzite. The biotite-plagioclase schist of Members 6 and 10, and the hornblende-plagioclase schist of Member 10 are chemically similar to andesites and basalts, but their plainly sedimentary character indicates that they were probably tuffs. The crystalline limestone is white, usually quite pure, and apparently unfossiliferous.

Conditions of Metamorphism.

Since the metamorphism of the schists progressively increases as the igneous contact is approached, their metamorphism is attributed to the heat generated in them by the surrounding magma. Increasing intensity of metamorphism in the direction of the igneous contact is shown by the facts that the rocks near the top of the section are only partially recrystallized, while those near the bottom are nearly or completely so; and that high temperature minerals such as sillimanite, tourmaline, and diopside appear only toward the bottom.

Age and Correlation.

The rocks of this series are apparently devoid of fossils in this quadrangle. The only fossils found in them elsewhere, so far as the writer knows, were reported by W. A. Goodyear in 1888.[3] He reported finding "some very poorly preserved, indistinct remnants of what were probably crinoidea" in a marble quarry in Bright's Valley, about 5 miles northwest of Bean Canyon. He stated that the marble is associated with slates and schists. It is quite possible that these rocks are correlatives of the Bean Canyon series. The presence of crinoid remains indicates a probable Paleozoic or early Mesozoic age for them.

The upper age limit is determined by the time of irruption of the granitic rock that surrounds and invades the schist series. To the north and west continuous exposures of granitic rocks pass into those of the Sierra Nevada, where they are known to be of late Jurassic or early Cretaceous age. There is little doubt that the granitic rocks of the Tehachapi Mountains are the correlatives of those of the Sierra Nevada region, and the age of the Bean Canyon schists is thus indirectly determined as older than late Jurassic.

Further indication of the age of the Bean Canyon series is furnished by a comparison with the rocks of the Inyo Range, 100 miles to the north. The Inyo Range presents a thick and almost complete section of Paleozoic and Triassic rocks which have been studied and described by Knopf and Kirk,[4] who state that "The Middle Triassic apparently consists of impure limestones and calcareous shales interstratified with sediments of volcanic origin, chiefly andesitic breccias." The lithologic similarity of the Bean Canyon series and the Triassic rocks of the Inyo Range is very close. The middle or late Triassic rocks there are chiefly volcanic, composed of andesitic and rhyolitic flows and tuffs for the most part. The basal part of the volcanic series interleaves with the underlying limestones of middle Triassic age. No fossils were found in the volcanic series and it is possible that they are partly Jurassic in age. These are exactly the characteristics of the Bean Canyon series, somewhat masked by metamorphism, but still very distinct. The probable identity of the rocks of the two areas is further emphasized by the fact that volcanic rocks do not appear in the Paleozoic rocks of the Inyo Range.

It is concluded, therefore, that the Bean Canyon series is probably in part Triassic and possibly in part Jurassic.

Metamorphic rocks of the general nature of those described here are widely distributed in the Tehachapi Mountains and extend northward into the Sierra Nevada. W. J. Miller[5] has recently described large metamorphic terrains in the Tehachapi Mountains between the towns of Tehachapi and Bakersfield, which he named the "Kernville series." The Bean Canyon series is probably the equivalent of part of the Kernville series.

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[3] Goodyear, W. A., Eighth annual report of the State Mineralogist of California, p. 310, 1888.

[4] Knopf, Adolph, and Kirk, Edwin, *op. cit.*, pp. 25–48, 1918.

[5] Miller, W. J., Geologic sections across the southern Sierra Nevada of California: Calif. Univ. Publ., Dept. Geol. Bull., vol. 20, pp. 331–360, 1931.

Pre-Cretaceous (?) Granitic Rocks.

Distribution and General Features.

Granitic, dioritic, and syenitic rocks occupy a considerable area south of the Sierra Pelona range, extending southward beyond the boundary of the quadrangle well into the San Gabriel Mountains. Gradational boundaries exist between the various types, indicating a general contemporaneity or overlapping of the periods of irruption. The rocks are mineralogically and chemically closely related, and it seems likely that they represent fractions or differentiates of a single magmatic body. Quartz diorite is the dominant rock type of this series; the diorites, syenites, and aplites occupy comparatively small areas adjacent to the Sierra Pelona.

Their intrusive relationship to the Pelona Schist series can not be proved directly, for the only visible contacts are along faults. However, the Pelona schists locally show the effects of superimposed contact metamorphism at several places along the Pelona fault, and one must suppose that the adjacent granitic bodies were the metamorphosing agents.

The relationship of these granitic rocks to known early Cretaceous granitic rocks is not apparent, for the two are nowhere in contact in this quadrangle. In the adjoining quadrangle to the south, however, W. J. Miller has observed an intrusive relationship between the older granitic rocks and granodiorite of supposed late Jurassic or early Cretaceous age.[6]

Age.

The older granitic rocks all show more or less granulation and in this respect differ from the supposed early Cretaceous granitic rocks. However, the two series are closely related petrologically and it is entirely possible that both are representative of the same general period of batholithic intrusion. O. H. Hershey[7] and W. J. Miller[8] have expressed the opinion that the older granitic rocks are of pre-Cambrian or Archean age, but no evidence has yet been adduced to prove that they are older than Mesozoic, or indeed, that they are not correlatives of the Sierra Nevada rocks.

Quartz Diorite and Quartz Monzonite.

Rocks of this general type bound the Pelona fault on the south from the head of Mint Canyon to the head of Pelona Valley; and from this point east to Little Rock Creek make up the greater part of the granitic rocks. There are many transitions to hornblende diorite on the one hand, and to aplite on the other, though the individual areas of these facies are not large. Hornblende is the most abundant ferro-magnesian constituent of the dioritic types, and biotite of the monzonitic, but there are abundant intermediate types containing both. The rocks commonly have a medium to coarse granitic texture, but fine-grained types are not rare. Andesine is the predominant type of plagioclase feldspar with microcline about equally abundant in the monzonitic types.

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[6] Miller, W. J., Anorthosite in Los Angeles County: Jour. Geol., vol. 39, p. 333, 1931.

[7] Hershey, O. H., Some crystalline rocks of Southern California: Am. Geologist, vol. 29, p. 279, 1902.

[8] Miller, W. J., *op. cit.*, p. 336,

Monzonite Aplite.

Grading into the diorites and monzonites is an area of aplite covering about 5 square miles. It bounds the Pelona fault on the south from the head of Sierra Pelona Valley to Anaverde Valley. The aplite is characterized by a fine grain and general absence of dark constituents. Usually, however, there is a very small amount of biotite present. Gradational types exist both with the quartz diorite and the syenitic rocks.

Examination under the microscope reveals the composition as about equally divided between oligoclase and microline perthite, with biotite, ilmenite, and titanite present in very small amounts. The aplite shows less granulation than the other rocks of this suite, due, perhaps, to its finer grain.

Syenite and Alkali Granite.

The area of these rocks covers about 4 square miles on the southeast flank of the Sierra Pelona. At its western boundary it grades into monzonite aplite; a fault relationship exists along part of the northern contact with the aplite. The rock is quite distinctive in the field, massive, even-granular, weather-reddened and exceedingly tough. Feldspar, quartz, and biotite are the only minerals usually determinable with the hand lens. The rocks from different parts of the area resemble each other closely, though the amount of quartz in different specimens ranges from 5 to 40 per cent. Microcline perthite ranges in amount from 58 per cent to 70 per cent of the rock. Oligoclase is present in small amounts as are green hornblende and biotite. Magnetite and titanite usually do not exceed 1 per cent each of the rock.

Granite Augen Gneiss.

This is exposed in two small areas near the heads of Texas and Mint canyons in the southwest part of the quadrangle. The rocks of the different outcrops differ considerably in size of grain. The direction of foliation most often seen is east-west, and the commonest dip is steep to the south. The physical relationship of the augen gneiss to the other rocks of the suite is either effectively masked by alluvium or obscured by faulting. Its lithology, however, clearly indicates a close relationship to others of the series, especially to the syenite. It probably represents a gneissose border phase of the pre-Cretaceous (?) batholith.

Upper Jurassic (?) Granitic Rocks.

Distribution and Character.

Granitic rocks of supposed late Jurassic or early Cretaceous age are exposed in much of the Tehachapi and San Gabriel Mountains, and over wide areas of the desert. They are continuous with the granitic rocks of the Sierra Nevada to the north and with the San Bernardino Mountains to the south.

On the plain of this part of the desert the granitic rocks crop out as scattered low hills and ridges and broad, almost flat platforms or pediments that rise very little above the desert floor. The low ridges of the pediments are invariably determined by the presence of the more resistant pegmatite dikes. The granite slopes of the Tehachapi and San Gabriel Mountains in this region are moderate, in general, from their bases to their summits. In the Tehachapi Mountains this gradual rise from the desert plain is interrupted by a zone of large roof-pendants (the Bean Canyon series) whose thick limestones stand out as prominent and rugged scarp. Farther up toward the crest, the moderate slope, averaging 18 degrees, ends abruptly against the Oak Creek Canyon fault; above the fault the slope is 32 degrees almost to the crest. The crest is broad and has the gentle, rolling topography of slight relief so characteristic of the mountain upland of Southern California. In the San Gabriel Mountains the moderate slope from the desert plain is interrupted by a great gash, the valley of the San Andreas rift. The upland of the San Gabriel Mountains within this quadrangle is several thousand feet lower than that of the Tehachapi Mountains, but is characterized by the same subdued topography.

The granitic rocks both of the mountains and desert show little chemical weathering but are greatly disintegrated due largely to the great daily range in temperature. The resultant coarse angular sand forms the talus cones and the alluvial fans of the mountains, and the desert floor in the vicinity of the granite pediments of the desert.

Two mappable units, quartz diorite and quartz monzonite, have been used to represent the distribution of the late Jurassic granitic rocks. They should not be considered to denote areas of homogeneous rock units, but as areas of related types of rocks, the averages of which are the units named. In the area mapped as quartz monzonite, and in which quartz monzonite is the most abundant type, the facies range from granite aplite and true granite to diorite, and the areas mapped as quartz diorite include both granodiorite and hornblendite.

The areas of the several types are ordinarily not sharply delimited; the types merge into each other as though they had originated as facies of the same magmatic body and not as separate intrusions. However, an intrusive relationship between quartz monzonite and hornblendite is plainly evident in the small area near the head of Cottonwood Creek. The hornblendite is there traversed by numerous thin veins of quartz monzonite, while elsewhere it shows gradational boundaries indicating that before the hornblendite facies had had time to solidify completely it was intruded by quartz monzonite.

Origin and Age.

The greater part of the magma presumably came from deep in the earth's crust, but locally, much of it must have formed through granitization of other rocks. Proof of this is abundantly furnished in a wide belt of granitic rocks north of and parallel to the Sierra Pelona, where very numerous bodies of injection gneiss show every gradation from true schist to undoubted granitic rock.

The age of the granitic intrusions, so far as can be determined in this quadrangle, is pre-Tertiary and probably post-Triassic, for the Tertiary rocks of this quadrangle have not been affected by the intruon while the Bean Canyon series, of probable Triassic age, has been truded and metamorphosed by them.

The granitic rocks of the desert, San Gabriel Mountains, and ehachapi Mountains, are considered to form part of the Sierra Nevada atholith, into which they are directly traceable.

Quartz Monzonite.

Quartz monzonite outcrops over much of the northern half of the uadrangle where it composes most of the granitic rocks of the Teha- hapi Mountains, of the San Gabriel Mountains north of the Sierra elona, and of the desert plain north of Rosamond. It is a massive, edium to coarse-grained, even-granular rock, gray when fresh, but ommonly weathered to a light red-brown. Biotite is the usual acces- ory, often accompanied by a little green hornblende. It is composed hiefly of quartz, microcline and andesine, of which the latter is some- hat the most abundant. The usual minor accessories are titanite, ircon, apatite, and magnetite, named in the order of abundance. A ost conspicuous feature of the quartz monzonite terrain of the desert s the large number of broad pegmatite dikes that traverse it. They ange in width from a few inches to 50 feet, and in length from a few ards to a mile. Because of their greater resistance to erosion, their utcrops are featured by knolls and ridges which stand above the sur- ounding granite. Their debris effectively masks the quartz monzonite, iving the impression that the whole terrain is pegmatite. The most rominent of these dikes forms the backbone of a low range of hills rending N. 65° W., 3 miles north of Rosamond Dry Lake. The pegma- ite consists essentially of pink microcline and quartz. It is very oarse-grained, crystals of microcline in places attaining 2 or 3 inches n length. Albite is usually present, though in very minor amount. he rock is remarkably free of accessory minerals; magnetite is the nly common one and it is very sparsely distributed. The quartz and nicrocline are usually graphically intergrown.

A very similar rock into which the quartz monzonite grades by mperceptible degrees is hornblende-biotite granodiorite, which makes p most of Sawmill Mountain, north and west of Hughes Lake. It is oarse-grained, the stumpy hornblende grains attaining a length of 1 entimeter. A linear arrangement of the dark minerals gives the rock gneissoid appearance. A typical specimen has a granitic texture nd an average grain size of 2 millimeters. Andesine makes up about half the rock; microcline, quartz, biotite, and common green horn- blende, each about one-eighth. Magnetite and apatite are common accessories, zircon and titanite rare.

Quartz Diorite.

Biotite-hornblende-quartz diorite is very close in appearance to the granodiorite just described, merges into the granodiorite, and occurs extensively in the area between Elizabeth Lake Canyon and San Francisquito Canyon. Euhedral basic andesine makes up 70 per cent of the rock. Biotite and green hornblende in nearly equal amounts compose 25 per cent and quartz 5 per cent of the rock. Magnetite, zoisite, zircon, and apatite, named in the order of abundance, are accessory minerals present in amounts of less than 1 per cent each.

Hornblende-quartz diorite occupies a large area in the Tehachapi Mountains north of the Oak Creek Canyon fault. The northwest corne of the quadrangle includes a small part of this area. The rock is distinctly gneissoid, and is locally composed almost entirely of hornblende. Like the quartz monzonite, which adjoins it south of the fault, it contains abundant xenoliths of schist and limestone, a certain indication of its magmatic origin. The hornblende grains average about 1 cm. in length and .5 cm. in width. They are linearly arranged in an east-west direction, parallel to the zone of roof-pendants; they are not arranged in any plane, and so the rock has no cleavage. The relationship of this rock to the quartz monzonite is not immediately apparent because of the fault that separates them, but an area of similar rock two miles south of the fault shows gradational boundaries with the quartz monzonite. The rock is composed 40 per cent of andesine feldspar, 35 per cent of common hornblende, 10 per cent of quartz, and 15 per cent of chlorite to which some of the hornblende has altered Crushing has imposed a granulitic texture on the rock, apparent whe seen in thin section.

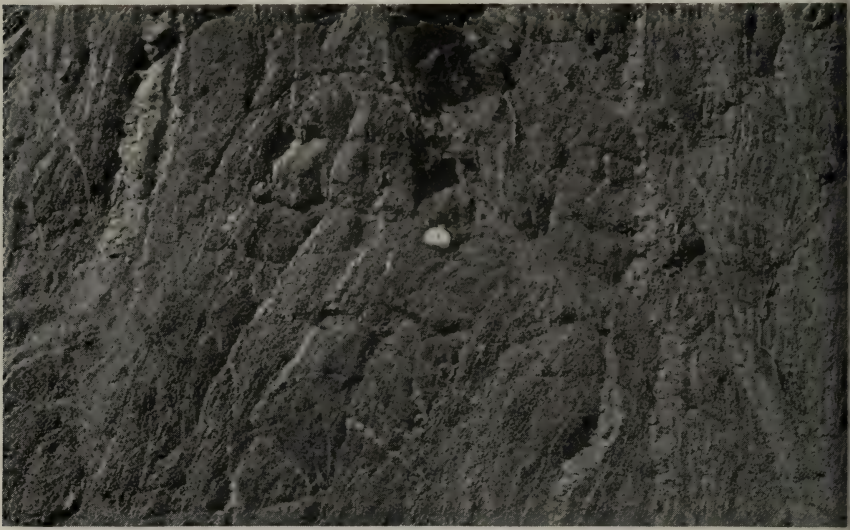

FIG. 4. Injection gneiss exposed on road between Bouquet and San Francisquito Canyons.

Injection Gneiss.

Bodies of injection gneiss are very abundantly included in th granitic rocks in an east-west zone about six miles wide bounding th Sierra Pelona on the north. Excellent sections of injection gneiss ar exposed in road-cuts of the Spunky Canyon road from Bouquet Canyo to San Francisquito Canyon, and in road-cuts along the Surge Tan road in San Francisquito Canyon. The individual areas of injectio gneiss are small and discontinuous, often separated by wide areas o hornblende diorite, hornblende-quartz diorite, granodiorite, or aplite Every gradation between biotite schist and true igneous rock can b seen in the excellent exposures along these roads. The gneisses hav general easterly strike and usually a steep or vertical dip. The ranitization of these rocks seems generally to have proceeded without arked displacement of the schists, for they do not appear to be regionlly folded. As the schists grade into aplite, for example, the planes of chistosity, marked by zones of biotite, become thinner and fainter, ntil the biotite entirely disappears, its former position marked only y scattered grains of magnetite. The transition of biotite schist into ornblende diorite is characterized by gneiss in which biotite and hornblende are intergrown, the proportion of hornblende increasing with creased distance from the schist. The transition zones range in width rom a few inches to over a hundred feet.

Movements of magma before the injection-gneiss zones were comletely solidified have resulted in locally contorting the injection neiss. Fine examples of contorted injection gneiss can be seen in oad-cuts on the Surge Tank road. Recurrent magmatic movements fter the injection gneiss was completely solidified has formed an ntrusion breccia, with blocks of gneiss torn away from their walls and nveloped in diorite or granodiorite. Examples of this can be seen in oad-cuts on the Surge Tank road and at the junction of San Franisquito Canyon and Leona Valley.

The proximity of the injection gneiss areas to the Pelona Schist ontact, and their general parallelism in strike to the Pelona schists ndicate the latter as the source rock. Their respective rock types are ot comparable because of the great changes wrought by thermal metaorphism on the injection gneiss. In contrast to the Pelona schists, he injection gneiss is coarse-grained and in texture much closer to an gneous rock than to a schist. The intervening Bouquet Canyon fault akes it impossible to trace the injection gneiss directly into the Pelona chists.

ocene Rocks. Martinez Formation.

Distribution and General Features.

A narrow fault block of Lower Eocene sediments is wedged in mong the crystalline rocks of the San Gabriel Mountains in the southvest part of the quadrangle. The apex of the wedge lies at the juncion of Clearwater, Bee, and Bouquet Canyons; it widens to the west ntil at the western border of the quadrangle it is two miles broad. It s bounded by faults which form an acute angle at the junction of ee and Cherry Canyons. Both are vertical or steeply dipping faults, vith vertical displacements of possibly thousands of feet. The Bouquet anyon fault brings the Martinez rocks in contact with Mesozoic ranitic rocks on the north; on the south the Bee Canyon fault brings he Martinez in contact with the Pelona schists for five miles of its ourse, and west of the junction with Bee Canyon, with rocks of the Escondido formation.

The Martinez rocks strike east-west and dip steeply to the south t angles ranging from 50° to 85°. The maximum thickness in this quadrangle is about 7500 feet, about two-thirds of which is sandy and ne-third shaly in character. The total conglomerate, though found frequently in thin lenses in the sandstone and even in the shale, will not aggregate more than 200 feet in thickness. The series is apparently onformable from top to bottom.

The formation consists of alterations of sandstone and shale in beds of variable thickness. Occasional thin lenses of well-rounded conglomerates are included in both the sandstone and shale strata. The sandstone beds are gray to buff-colored, thin-bedded, heavy-bedded, or massive, and range from fine to coarse-grained, with medium-grained sandstones predominant. They are usually very hard, well-cemented with calcite and subordinate iron oxide. The fresh exposures encountered in the canyon bottoms are gray, the weathered exposures buff yellow. The shales are dark-brown to black, often replete with carbonaceous matter, thin-bedded, in units that range in thickness from a fraction of an inch to 400 feet. They have been compressed to almos a slaty consistency.

Petrology.

The section from top to bottom presents a monotonous sameness. Buff-colored sandstone alternate with dark shale, and occasionally a thin bed of conglomerate. Feldspar and quartz grains are present in about equal amounts in the sandstone, with biotite and muscovite in very subordinate amounts. The grains are usually more angular than rounded. The pebbles of the conglomerates are all well rounded, som of them almost spherical. An exceptionally large one measured 3 inche in diameter. The average is much smaller. The pebbles consist of quartz diorite, granodiorite, granite pegmatite, andesite, and quartzite Under the microscope, average specimens of the sandstone are seen t be composed 40 per cent of quartz grains; oligoclase and andesine abou 50 per cent, microcline 5 per cent, and biotite 5 per cent. In a heav mineral separate, titanite, magnetite, ilmenite, biotite, and muscovit were most abundant; common hornblende, zircon, pink and orang garnets, epidote, and actinolite less abundant; brown tourmaline and hypersthene grains rather scarce.

The mineral analysis indicates the granitic rocks of the region a probably the main source of the sediments. The actinolite and garne point to schist or contact rocks as the source of part of the sediments and the hypersthene to a volcanic source.

Conditions of Sedimentation.

Deposition in the sea is indicated by the presence of marine fossil in many parts of the section. The abundant carbonized wood fragments and the coarseness of much of the sandstone indicate depositio not far from shore. That the sediments were quite fresh whe deposited is shown by the angularity of the grains and by the preponderance of grains of feldspar, a mineral that is very liable t destruction through weathering and erosion. The freshness of th sediments may be interpreted as meaning either that the climate wa an arid one unfavorable to chemical weathering, or that the sediment were derived from a land surface undergoing such rapid erosion tha the minerals were not long exposed to atmospheric action. The latte seems the more acceptable hypothesis, as the Eocene climate is known t have been warm and humid in the Pacific Coast region.

Age and Correlation.

The evidence for the Martinez age of these rocks depends on a fe poorly preserved fossils. Fragments of carbonized wood occur i abundance in both sandstone and shale in many parts of the section. The borings of marine worms riddle the sandstone of several horizons. Molluscan remains appear here and there in many parts of the section, but in such poor condition as to be valueless for correlation purposes. The shales seem exceptionally barren, but in one stratum the casts of foraminifera were found, one of which was in good condition. It was determined by Professor H. G. Schenck of Stanford University to be a costate *Nodosaria,* an Eocene or Paleocene form. Mr. Thomas Clements, who has studied the Martinez rocks in the Tejon quadrangle, immediately to the west, states that there they are in depositional contact with granitic rocks and are uncomfortably overlain by Sespe sediments of Miocene or Oligocene age.[9] He has found a few molluscan remains in them which he has identified as forms typical of the Martinez formation, of early Eocene age.

Miocene Rocks.

Rocks assigned to the Miocene age are widely distributed over the Elizabeth Lake quadrangle and the adjacent areas. In Antelope Valley and the Rosamond Hills they are called the Rosamond series and consist of unfossiliferous continental conglomerates, sandstones, tuffs, basalts, dacites, and limestone. In the San Gabriel Mountains they are known as the Escondido formation, consisting of conglomerates, sandstone, shales, tuffs, basalts, and dacites. This formation is also unfossilferous and of continental origin. The similarities of the two formations are apparent. They differ in that in the Rosamond series the volcanic rocks are mainly dacitic, while in the Escondido they are mostly basaltic. At their nearest points in this quadrangle they are separated only by the width of Portal Ridge, a distance of five miles. The age of these formations is not certainly known, as they are unfossiliferous and can not be traced into rocks of known age. However, similar rocks at widely separated localities in the Mojave Desert contain remains of Upper Miocene mammals. They have been correlated with the type section of the Rosamond in this quadrangle on the basis of lithological similarity.

Distribution and General Features of the Escondido Formation.

Rocks of the Escondido formation outcrop over an extensive area in the southern part of the quadrangle and in the quadrangles adjoining to the west, south, and southeast. They consist of continental conglomerates, sandstones, shales, and basaltic and dacitic flows and tuffs. In Tick Canyon, a short distance from the southern boundary of the quadrangle, beds of colemanite and thin beds of limestone are interbedded with sandstones and shales of this formation.

This formation was first described in 1902 by O. H. Hershey,[10] who designated them the ''Escondido series,'' a succession of beds of volcanic rocks and continental sediments exposed near the head of Escondido Canyon, and the south end of Pelona Valley. Only a few hundred feet of the type section lie within this quadrangle; the rest lies within the Fernando quadrangle to the south. Outcrops are almost continuous eastward across the southern end of the quadrangle to Palmdale and the San Andreas rift valley. They closely resemble a series of beds that are exposed in Texas Canyon and the head of Mint Canyon, and are correlated with them, though the outcrops are not continuous from one area to the other.

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[9] Clements, Thomas, Extent of the Paleocene Sea in the southerly part of the Tejon quadrangle, Calif.: Bull. Geol. Soc. Am., vol. 43, p. 226, 1932. (Abstract.)

[10] Hershey, O. H., Some Tertiary formations of Southern Calif.: Am. Geol., vol. 29, pp. 350–355, 1902.

In 1924 Kew [11] tentatively correlated the rocks of Escondido Canyon and Texas Canyon with the Sespe formation of lower Miocene and Oligocene age on the basis of lithological similarity and proximity to the type section in Santa Clara Valley. His opinion that the Escondido formation is probably in part equivalent to the type Sespe seemed well grounded at that time, but as evidence resulting from this and other later studies indicates that it is probably of middle Miocene age, it has been thought best to retain the name ''Escondido'' to apply to rocks of this and adjoining quadrangles that Kew tentatively assigned to the Sespe formation.

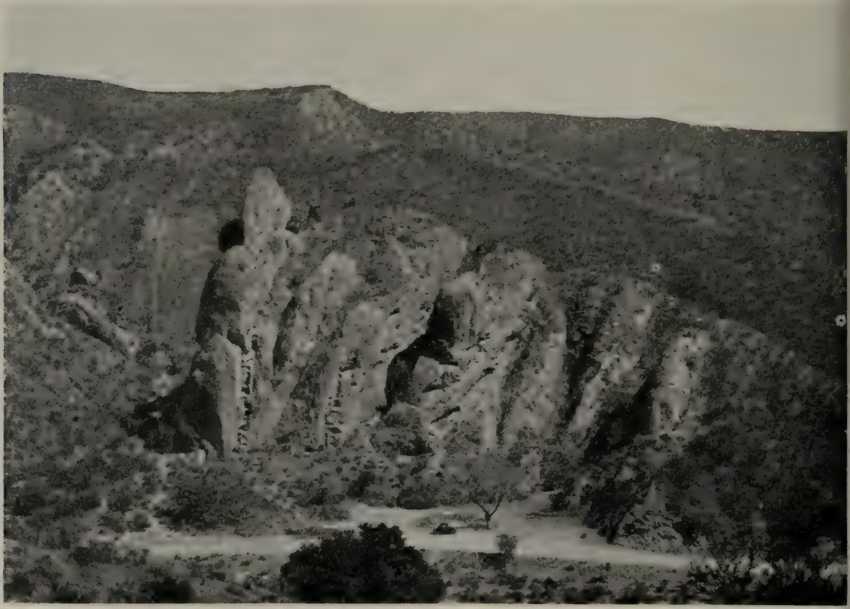

FIG. 5. Sandstone and conglomerate of the Escondido formation up-ended along the Pelona fault at the mouth of Bouquet Canyon.

The Texas Canyon area of Escondido rocks comprises about 5 square miles in the southwest part of the quadrangle. On the north and northwest it is in fault contact with the Pelona schists and quartz diorite; on the southeast in fault contact with quartz diorite and granite gneiss; on the northeast it is in depositional contact with granite gneiss. A half mile south of the southern boundary of the quadrangle the Escondido is overlain with angular unconformity by the Mint Canyon formation composed of coarse continental sediments of Upper Miocene age.

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[11] Kew, W. S. W., Geology and oil resources of a part of Los Angeles and Ventura Counties, California: U. S. Geol. Survey, Bull. 573, pp. 38–40, 1924.

The Escondido formation here is represented by a series 5000 feet thick of conglomerates and sandstones and a few thin shale beds. The strata have a general east-west strike and dip 40° to 60° south, and rest with depositional contact on granitic rocks. The lower 4000 feet is composed chiefly of coarse sands and conglomerates, brick-red, and poor or lacking in cement. The upper thousand feet, though lithologically very similar, is gray, and better cemented. Many of the beds are very firmly cemented with calcite. Erosion working upon the steeply-dipping strata of different degrees of cementation, has produced some very striking forms. There are a few thin beds of shale and fine-grained sandstone at widely separated horizons in the section At several horizons the red beds contain a strong admixture of volcanic debris, consisting of pumice and small fragments of basalt and obsidian.

The coarseness of this series of sediments is very striking. Much the greater part of it may be classed as conglomerate, and a large part of the remainder as boulder beds. Some of the boulders are of great size and weigh several tons. Curiously enough, the beds become noticeably coarser high in the section. The base of the series is represented by several hundred feet of medium-grained sandstone containing a good deal of clay. It is overlain by alternations of coarse, heavy-bedded sandstone and conglomerate beds and occasionally a boulder bed. The heaviest boulder beds occur in the upper thousand feet. Except for the small amount of volcanic debris the pebbles and boulders are of granitic rocks of the sorts that form the basement rocks of the region. Hornblende-quartz diorite fragments seem the most abundant, but there are also a great many of granodiorite, quartz monzonite, aplite, and granite pegmatite. They seem quite unweathered except for the coating of iron oxide that gives them their maroon color. In view of the fact that a large area of Pelona schists bounds the Escondido on the north, it is remarkable that no Pelona schist fragments are found in the Escondido sediments. Here, as elsewhere, the Escondido formation seems utterly barren of fossils.

Sediments comparable to these are accumulating today at the foot of the steep eastern escarpment of the Sierra Nevada. Similar conditions probably controlled the deposition of the Escondido sediments. Certainly, they accumulated swiftly in the lowlands of a region that was undergoing rapid degradation, a region of considerable relief. Later the difference in relief between the region undergoing erosion and that receiving sediments apparently became greater, for the sediments above the basal beds are predominantly conglomerates and boulder beds which become heavier, in general, toward the top of the section. They seem best explained as fanglomerates that accumulated at the foot of a region of growing elevation, not improbably a fault scarp undergoing periodic uplifts. The nature of the detritus composing the Escondido sediments of this area indicates their probable derivation from the region to the north and east rather than from the south, for the sediments, though composed of granitic detritus, lack debris of the anorthosite so abundant in the granitic terrain south of the quadrangle.

Escondido Canyon trends north for some 6 or 7 miles from the floor of Soledad Canyon, and heads within the Elizabeth Lake quadrangle close to the center of its south boundary. In it is exposed a magnificent section of the Escondido series, 8000 feet thick, of which about half is lava flows and the rest conglomerates, sandstones, and shales. This is the type section of the formation that O. H. Hershey named the ''Escondido series'' and which he considered to be closely related in time to the Rosamond series.[12] The general features of the Escondido here are very close to those of the Texas Canyon occurrence, but differ in the great thickness of lava flows that characterizes the Escondido Canyon section. The rocks have a general east-west trend and dip steeply to the south. The basal bed is a heavy conglomerate in depositional contact with granitic rocks. It is about 40 feet thick, poorly stratified, and composed of detritus of granitic rocks identical with those upon which it rests. It is overlain by about 300 feet of red sandstone, most of which is very fine-grained, and which contains a few lenses of angular conglomerate. It is mostly thin-bedded, with beds averaging about 3 inches thick; some are of paper thinness. Cross-bedding and local disconformities are abundant in some horizons. Fossil worm trails abound in certain of the fine-grained sandstone beds. The sandstone is overlain by another massive conglomerate about 60 feet thick, with boulders up to 3 feet in diameter and showing very little rounding. Besides granitic and granitic gneiss boulders of types identical with the underlying basement rocks, there is a great number of rocks composed entirely of andesine feldspar. These are believed to have been transported here from the region 8 miles to the south, where this anorthosite crops out over a large area. It is not known to occur elsewhere in Southern California, and hence indicates the source of at least part of the sediments. The boulder bed is overlain by a series of lavas 3700 feet thick, basaltic for the most part, and this in turn by about 4300 feet of pink and buff-colored conglomerates, sandstones, and shales. Here, as in Texas Canyon, the Escondido is overlain with angular unconformity by the Mint Canyon formation.

Erosional remnants of the lava flows are of frequent occurrence in the southern part of the quadrangle and are almost continuous in the quadrangle to the south as far east as the San Andreas rift valley. These basalts undoubtedly once covered all this region. In the vicinity of Little Rock Creek and south of the San Andreas rift, several hundred feet of basalt flows are overlain by about 1200 feet of coarse sandstones and conglomerates, red and pink for the most part, but with some grayish and yellowish strata. The material composing the sediments is granitic and basaltic debris, rather poorly consolidated. The rocks dip into the rift valley at an angle of 45°. As the upper part of the formation is hidden under the alluvium of the valley floor it is not unlikely that the formation may here have twice the thickness exposed. In the rift valley, east of Harold Reservoir, a strip of Escondido formation, bounded by northwest faults, contains a bed of gypsiferous brown shale which can be traced for several miles in the valley. It ranges in thickness from 50 to 200 feet. In the vicinity of Palmdale it has been mined for gypsum.

South of Palmdale and north of the rift, and in a zone bordering it, tightly cemented coarse sandstones and conglomerates occur, identical with those forming the upper thousand feet of the Escondido in Texas Canyon. Alluvium masks the formation for the most part, but outcrops of beds dipping steeply to the north occur here and there for a half mile north of the rift valley. Its exposed thickness is estimated at 2000 feet. Within the rift valley, Escondido sandstones and conglomerates occur in long narrow strips faulted downward into the granite from Elizabeth Lake eastward for an unknown distance into the Rock Creek quadrangle.

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[12] Hershey, O. H., *op. cit.*, p. 370.

Three and a half miles south of Palmdale the Escondido volcanics have been over-ridden from the north by granitic rocks. Near the fault trace a stratum of dacitic obsidian 35 feet thick, overlain by dacitic tuff, locally over 100 feet thick, occurs intercalated in the basaltic rocks.

Age and Correlation.

In the quadrangles to the south and west, the Escondido is overlain unconformably by continental sediments of late Miocene age, the Mint Canyon formation. In the Tejon Quadrangle, it rests unconformably upon the Martinez formation of early Eocene age.[13] The age limits are thus placed at lower Eocene and upper Miocene. But as there is a great lithological dissimilarily between the Escondido and the Martinez formations, it would appear to be more closely related in time to the Mint Canyon formation than to the Martinez formation.

The recently published work of Hoots[14] on the geology of the Santa Monica mountains affords more than a hint of the age of the Escondido formation. A study of his work brings out striking fundamental similarities of the Topanga formation of the Santa Monica mountains and the Escondido formation, both in lithology and stratigraphic position. Both formations are composed chiefly of conglomerates, coarse sandstone and flows of basalt. They are of the same approximate thickness: the maximum of the Escondido formation is 8400 feet, and that of the Topanga is about 7500 feet. Both are overlain with angular unconformity by formations of upper Miocene age: the one by the Mint Canyon formation, and the other by the Modelo formation. Some twenty miles, the width of the San Fernando Valley, separate the outcrops of the two formations. They differ in only one important respect; namely, that the Escondido accumulated subaerially and the Topanga under marine conditions. The Topanga contains abundant marine fossils that fix its age as middle Miocene. Now, nowhere in this part of California are basalt flows present in Tertiary rocks known to be older than the Topanga formation. In view of this and of the similarities of the two formations, there is a strong probability that they are age equivalents.

Distribution and General Features of the Rosamond Formation.

The name *Rosamond formation* was applied by O. H. Hershey[15] to a series of tuffs, sandstones, conglomerates, volcanic flows and agglomerates exposed in the low hills about 1 mile north of the village of Rosamond. Later he extended the name to similar rocks, widespread in the Mojave Desert, notably at Barstow and Red Rock Canyon. Hulin[16] has reported large areas of Rosamond rocks in his report on the Randsburg quadrangle. Everywhere it has the same general characteristics; thick nonmarine accumulations of sandstones, conglomerates, and cobble-beds, together with beds of white volcanic ash, and in places thick flows of dacite, rhyolite, and basalt. These rocks display a striking variety of colors with tones of dark-red and yellow predominant. The conglomerates and cobble-beds are deep

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[13] Clements, Thomas, *op. cit.*, p. 226.

[14] Hoots, H. W., Geology of the eastern part of the Santa Monica Mountains, Los Angeles County, California: U. S. Geol. Survey, Prof. Paper 165-C, 1931.

[15] Hershey, O. H., *op. cit.*, pp. 365–372.

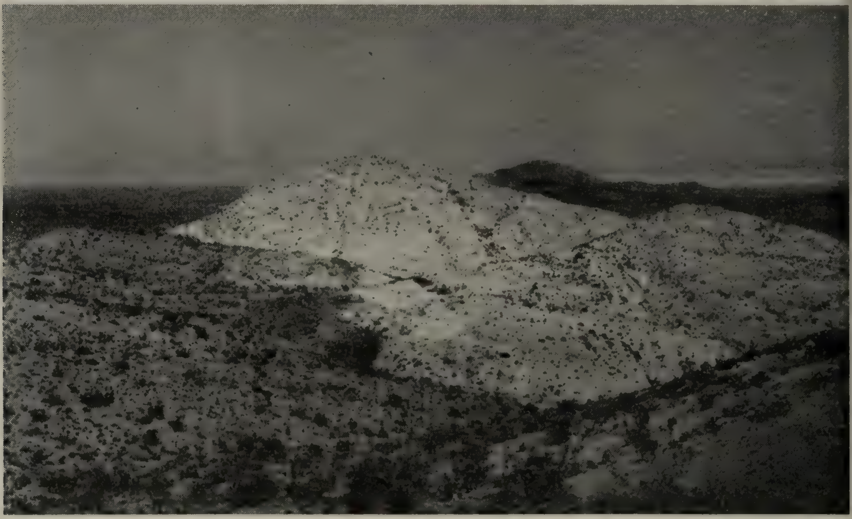

FIG. 6. Rhyolite tuff beds of the lower Rosamond formation lying on tilted erosion surface of granite. 1 mile north of Rosamond.

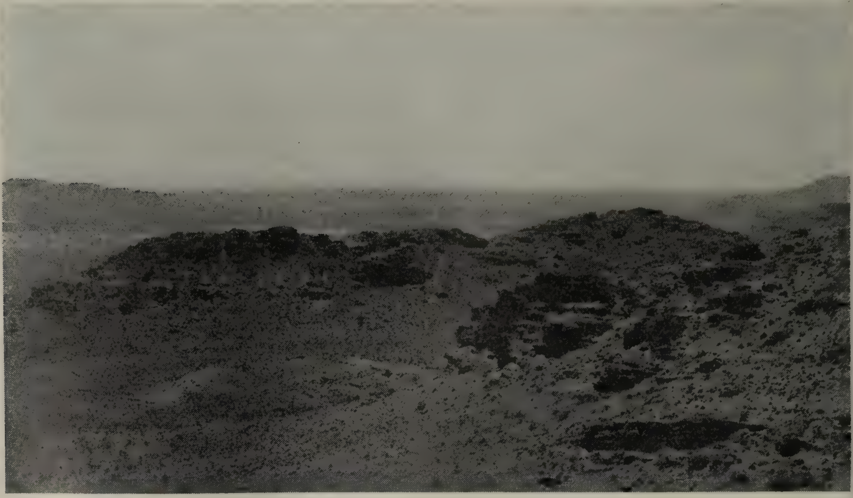

FIG. 7. Sandstone and conglomerate beds of the upper part of the Rosamond formation, Rosamond Hills.

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[16] Hulin, C. D., *op cit.*, p. 42.

red, both from the original color of the dacite and granite fragments that compose it and from subsequent weathering. The sandstones are usually gray, but some beds are pure white because of the abundance of pumice they contain. The ash or tuff beds are usually white, but in places are stained yellow with sulphur and in other places green from the action of mineral springs. Most of the dacites and rhyolites are red, doubtless their original color, but exposures of white dacite and rhyolite are not rare. In the lower part of the series a tone of dead-black is usually added by thin flows of basalt which occur within the sequence of dacites and rhyolites. These are the general characteristics of the series over a wide area but the different sections vary greatly in detail, even when not far distant from one another. This is seen in the accompanying figure which shows columnar sections of the principal Rosamond accumulations in this quadrangle. Locally, the Rosamond formation consists partly of lake deposits: thin-bedded silts and sandstones, banded cherts, and limestones.

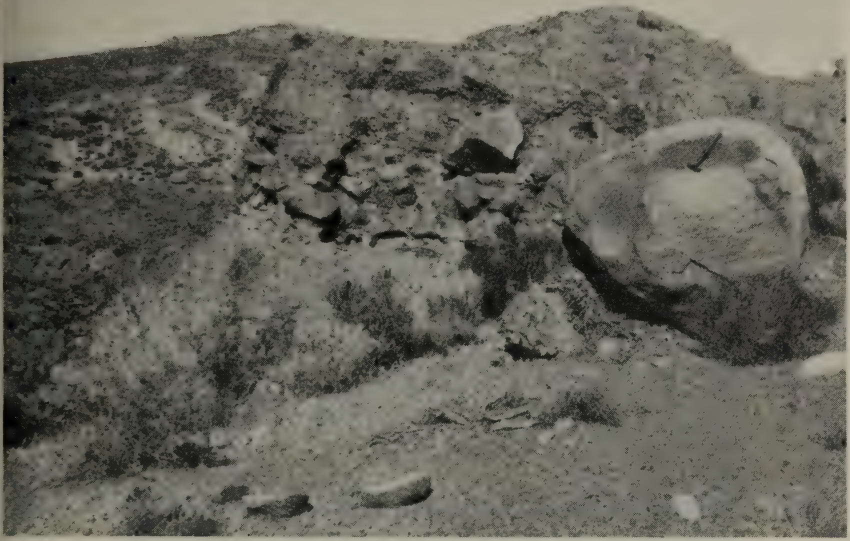

FIG. 8. Detail of one of many boulder beds of the upper part of the Rosamond formation, Rosamond Hills.

Most of the hills in the northern half of the quadrangle are erosional remnants of the Rosamond formation. Owing to different degrees of hardness of the rocks of the series and to their angles of inclination, weathering has produced extremely rugged forms in these barren hills. Most prominent of the hills is Soledad Mountain near the northern boundary of the quadrangle, an imposing pile of red dacite principally, rising several thousand feet above the surrounding plain. It is heavily mineralized and has a long history as a producer of gold and silver. Doubtless it is one of the former volcanic centers of the region. South and west of it the hills are much lower, but consist chiefly of stratified rocks, non-volcanic in character. The one exception and the next highest hill is Willow Springs Mountain, near the village of that name, which consists of a sequence 2700 feet thick of dacite flows and flow-breccias dipping steeply to the north, and cut off on the south by the Rosamond fault. It, too, must represent a former volcanic center. In the hills immediately north of Rosamond village, the section described by Hershey[17] corresponds to the lower third only of the sections represented in the hills 3 or 4 miles to the northwest and in the Antelope Buttes (Fairmont Hills), 12 miles southwest. The lack in Hershey's section is, of course, due to degradation by erosion. The lower part is characterized by the presence of volcanic flows, breccias, and ash beds in the sequence; the upper part consists entirely of heavy-bedded conglomerates and boulder beds, separated by thin beds of coarse sandstone. These beds present a remarkable appearance both for the curious forms worked by differential erosion and for the enormous size of some of the boulders, many of which range in weight from 10 to 25 tons. Lake deposits are represented to some degree in all exposures of the lower Rosamond in this quadrangle, but at Little Buttes, near the center of the quadrangle, and at Bissell, in the northeast corner, the entire sections are lacustrine. At Little Buttes the series consists of thin-bedded silts and sandstones with many intercalated beds of banded chert and white limestone containing flint nodules. Many of the beds are decidedly pumiceous, and some, besides pumice, contain abundant angular fragments of dacite and obsidian. The exposed section near Bissell consists of some 200 feet of alternating beds of dark shale and cherty limestone. Beds of magnesite of economic importance are included in the eastern part of the exposure. The Middle Buttes, a group of flat-topped hills lying four miles west of Soledad Mountain, is an outcrop of lower Rosamond

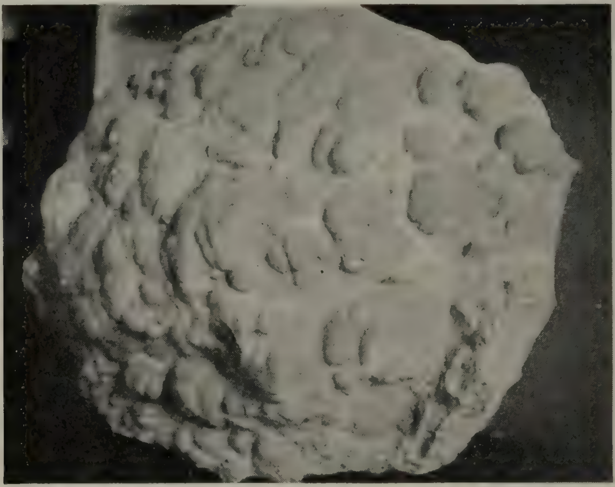

FIG. 9. Spherulitic dacite obsidian from the base of a dacite flow in the lower Rosamond formation, 1½ miles northeast of Rosamond.

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[17] Hershey, O. H., *op. cit.*, pp. 365–372.

rocks thoroughly impregnated with silica, probably through the agency of siliceous springs. In places silica has completely replaced the original rocks. The base of the Rosamond formation, exposed at several places in the Rosamond Hills and in the Antelope Buttes (Fairmont Hills), is a granite erosion surface, the moderate relief of which is evident both from the little granite hills that project upward into Rosamond rocks and from the variation in character of the rocks that form the lowermost Rosamond at different localities.

The heavy conglomerates and boulder beds of the upper Rosamond are witnesses of marked changes in relief here during Rosamond time. They are undoubtedly fanglomerates which accumulated at the foot of formidable escarpments. And these can only have come into being through large-scale faulting. This condition was regional, as is shown by the similar character of the Rosamond at Barstow and Randsburg.

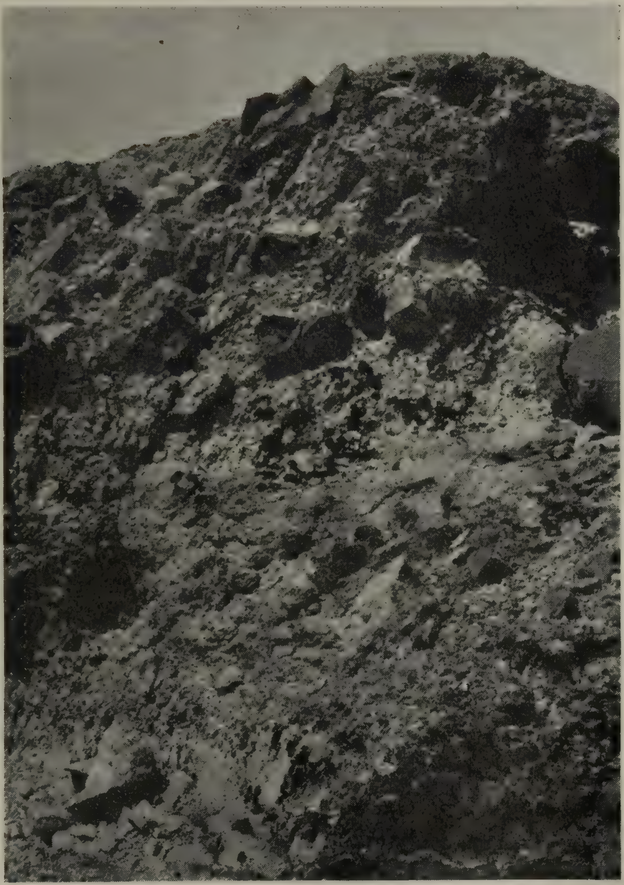

FIG. 10. Dacite flow-breccia in the lower Rosamond formation, Rosamond Hills. The blocks of dacite are set in a silicified matrix of pumice and sand.

Age and Correlation

Lacking fossil evidence, the age of the Rosamond in this region can not be conclusively demonstrated. Such fossils as have been found are of reeds, calcareous algae and fragments of silicified wood, all rather useless in correlation. But abundant mammalian remains have been found in the upper members of the Rosamond at Barstow, and determined by J. C. Merriam [18] to be Upper Miocene forms. This age may be accepted as not far wrong for the Rosamond of the Elizabeth Lake quadrangle. However, it is possible to arrive at a closer approximation of the age of the Rosamond here, even though fossils are lacking, by considering the relationship of the Rosamond to the Escondido formation, and the relationship of both to the great period of faulting in late Tertiary time. Unimpeded drainage to the sea of the desert region is indicated for Tertiary time prior to the deposition of the Rosamond, for that formation lies directly upon a granite erosion surface. No Tertiary rocks older than the Rosamond have been found in the Mojave Desert, and it can not be doubted that the entire region

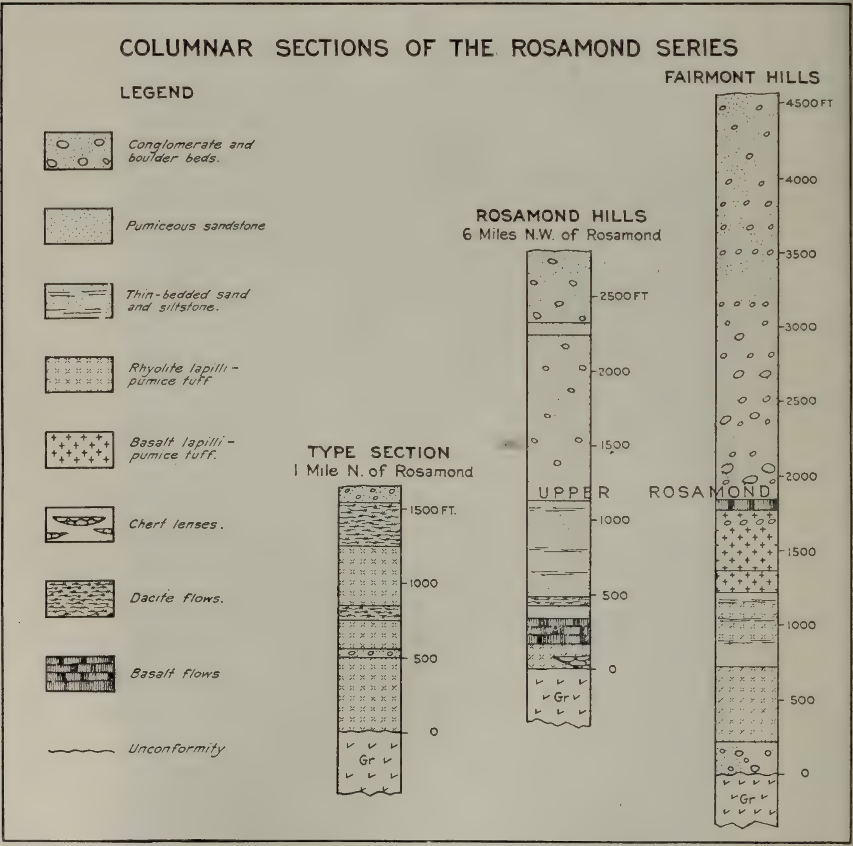
COLUMNAR SECTIONS OF THE ROSAMOND SERIES
LEGEND
Conglomerate and boulder beds.
Pumiceous sandstone
Thin-bedded sand and siltstone.
Rhyolite lapilli-pumice tuff
Basalt lapilli-pumice tuff.
Chert lenses.
Dacite flows.
Basalt flows
Unconformity
TYPE SECTION
1 Mile N. of Rosamond
1500 FT.
1000
500
0
Gr
ROSAMOND HILLS
6 Miles N.W. of Rosamond
2500 FT
2000
1500
1000
500
0
Gr
UPPER ROSAMOND
FAIRMONT HILLS
4500 FT
4000
3500
3000
2500
2000
1500
1000
500
0
Gr

FIG. 11. Chart showing correlation of three columnar sections of the Rosamond series.

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[18] Merriam, J. C., Tertiary mammalian faunas of the Mohave Desert: Univ. Calif. Publ., Dept. Geol. Bull., vol. 11, pp. 438–585, 1919.

was undergoing erosion during most of Tertiary time. Accumulation of the Rosamond therefore dates from the time of destruction of the drainage to the Pacific, that is from the time of elevation of mountain barriers across the paths of drainage. This argument applies with equal force to the date of accumulation of the Escondido formation, which the Rosamond closely resembles. But the age of the Escondido is more closely known because it is overlain by the Mint Canyon formation of known Upper Miocene age, and because it closely resembles lithologically the Topanga formation, of known Middle Miocene age. Middle Miocene age is thus strongly indicated for the Escondido formation and likewise, though with less force, for its probable correlative, the Rosamond formation.

Quaternary Rocks.

The Quaternary system comprises the unconsolidated gravels, sands, and clays of alluvial and eolian origin that overlie the older rocks of much of the quadrangle. It has been mapped as recent alluvium, older alluvium, playa deposits, and dune sands.

Extensive areas of the alluvial fans at the foot of the Tehachapi Mountains and of Portal Ridge are considered older alluvium, for they have not received increments of sediment for a long period. Most of the alluvium is a heavy fanglomerate, but in the deeper portions exposed by Cottonwood Creek and the canyons west of it, the sediments are medium and fine-grained sands, silts, and clays, with only an occasional bed of conglomerate. Only 400 feet of it is exposed, but a well drilled at the month of Cottonwood Creek is reported to have passed through 3300 feet of it. Its maroon color indicates that it was deposited under moister conditions than exist today. The fineness of the sediments contrasts with the coarse fanglomerate that is being deposited now, and suggests that the region then was one of lower relief.

High bench gravel, mapped as older alluvium, is recognizable over an area of about 10 square miles between Mint and Texas Canyons. It is about 25 to 100 feet thick, composed mostly of Pelona schist detritus. It has been worked for its meager content of placer gold for many years. The benches occupy the ridges between canyons, in places as much as 700 feet above the canyon floors.

The recent alluvium is composed mostly of gravels and sands derived from the adjacent highlands; very little of it is residual. It forms a loamy soil over most of Antelope Valley, where it supports a numerous agricultural population. The valley is an artesian basin, in most places yielding an abundance of water at moderate depths. There are a number of flowing wells near Lancaster and in Rosamond Dry Lake. The playa deposits constitute the bed of Rosamond Dry Lake, one of a series of playas that extend for many miles to the east and northeast. In the rainy season these basins receive a foot or two of muddy water, which upon evaporation deposits a thin layer of saline mud on the surface. Upon drying there is left a dazzling white layer of efflorescent salts. The salts are subsequently swept away by the wind, leaving a hard, wind-polished mud surface. Dune sands bound the playa on the east and southeast. Most of them are low hummocks of loose sand, but those nearest the eastern margin of the lake rise 50 to 60 feet high, and are partially cemented with calcite and gypsum.

STRUCTURAL GEOLOGY

Structurally the Elizabeth Lake quadrangle is part of the Great Basin, a vast area of western North America extending from Utah to California, characterized by fault-block basins and mountain ranges. During the Tertiary epoch this great region underwent elevation and erosion, exposing crystalline rocks over most of the region. In late Tertiary time the earth's crust here suffered great stresses to which the crystalline rocks (granites, gneisses, and schists) responded by faulting. From evidence gathered in this quadrangle, this period of faulting dates from the middle Miocene and continues to the present day, though apparently with abated vigor. Along the fault lines established so long ago the relative displacement of adjacent parts of the earth's crust has usually been great, amounting to thousands of feet and even miles. As the parts affected are bounded by faults they are referred to as fault-blocks. The elevated blocks are the highlands and mountain ranges of the Great Basin; the depressed blocks in between are the basins.

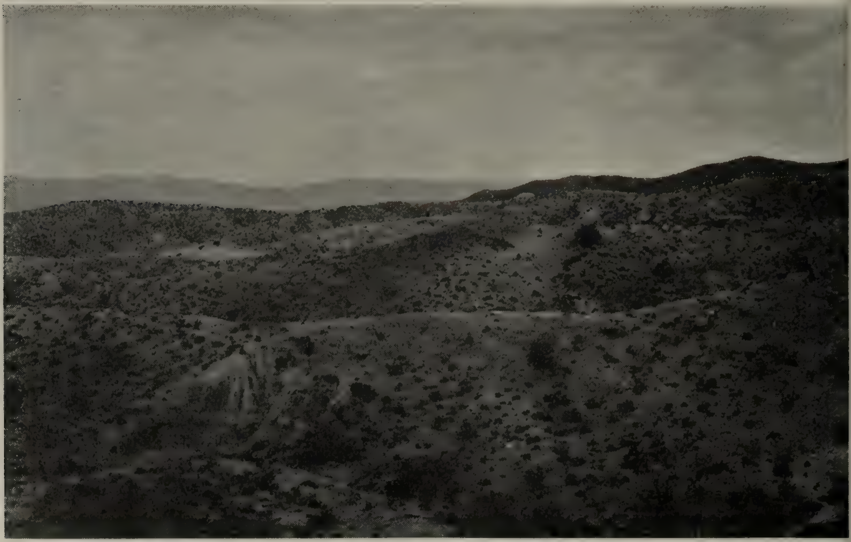

FIG. 12. Elevated and dissected alluvium near the foot of the Tehachapi Mountains south of Cottonwood Creek.

In this sense the structural units of this quadrangle are fault-blocks. The elevated blocks comprise the Tehachapi Mountains, the Rosamond Hills area, Sawmill Mountain, and Sierra Pelona; the chief depressed blocks are Antelope Valley and parts of the San Andreas rift valley.

The most conspicuous fault in this region, indeed, one of the most remarkable of all crustal rifts, the San Andreas, passes diagonally across the southern half of this quadrangle. This rift is in few places a simple fault, but is usually a system of two, three, or more closely spaced, approximately parallel faults all with steep or vertical dips. Along the course of the rift these faults repeatedly split up and rejoin, defining narrow fault blocks, some of which are many miles long.

Most often these have slumped, giving rise to a trough or rift valley, not only here but along much of its 500-mile course. In this quadrangle, adjoining parts of the rift valley are known as Pine Canyon, Leona Valley, and Anaverde Valley. The rift trends N. 65° W. across the quadrangle, roughly marking the boundary between the Mohave Desert and the San Gabriel Mountains. It bounds many fault-blocks, some of which have been elevated and others depressed, among them, in this quadrangle, Antelope Valley, Sierra Pelona, and Sawmill Mountain. Besides defining fault-blocks, the San Andreas appears to be the site of grander displacements of the earth's crust, involving regional movements. At the time of the San Francisco earthquake in 1906 the region south of the fault was displaced to the north. Data gathered by L. F. Noble and other investigators indicate this as the sense of all recent movements. The total regional displacement is not known, though it is probably large, but it is not sure that the movements have always been in the same direction as the recent ones. Indeed, there is evidence in this quadrangle which would indicate that the regional displacement has been in the opposite direction; specifically, that the region north of the rift has been displaced about 9 miles to the northwest. This is strongly suggested by the fact that the Sierra Pelona on the south side of the rift is matched petrologically and structurally by a fault-block on the opposite side 9 miles to the northwest. The bodies have similar structural trends, approximately the same width, and are bounded by similar faults and rock bodies. Such an enormous displacement would indicate great antiquity of the rift, reaching, at a guess, far back into the Mesozoic era.

The Garlock fault is traceable as a distinct rift from the south end of Death Valley westward across the desert to the vicinity of Randsburg, and from there, curving gradually to the southwest, along the foot of the Tehachapi Mountains into the Elizabeth Lake quadrangle. Its trace is lost beyond the western limit of the quadrangle but taking into account its great displacement in this quadrangle, it probably continues hidden under alluvium to strike into the San Andreas rift near the head of Antelope Valley. Its course is masked in this quadrangle east of Cottonwood Creek by alluvium, but for 4 miles southwest of that creek its trace lines up exactly with the trace of the Garlock fault in the Mojave quadrangle to the north. Where visible in this quadrangle, its trace is marked by a belt of uplifted and folded alluvium, the upthrown side to the north toward the Tehachapi Mounttains. The deformed alluvium is a canoe-shaped dome 5 miles long, elongate parallel to the fault. Near the fault contact the alluvium dips 80° to 87° to the southwest; away from it the dips rapidly become gentle, and the steepest dip recorded on the northwest limb of the fold is 9°. The fault plane hades to the north, but the straight course it runs through country of different elevations indicates that the hade is close to vertical. The vertical displacement that can be measured in the folded alluvium is about 400 feet. However, the well bored by the Meridian Oil Company near the mouth of Cottonwood Creek and 1000 feet east of the fault, passed through 3300 feet of alluvium, according to the driller's log, before striking granite. Thus a throw of 4000 feet is indicated with the probability that it occurred during Quaternary time.

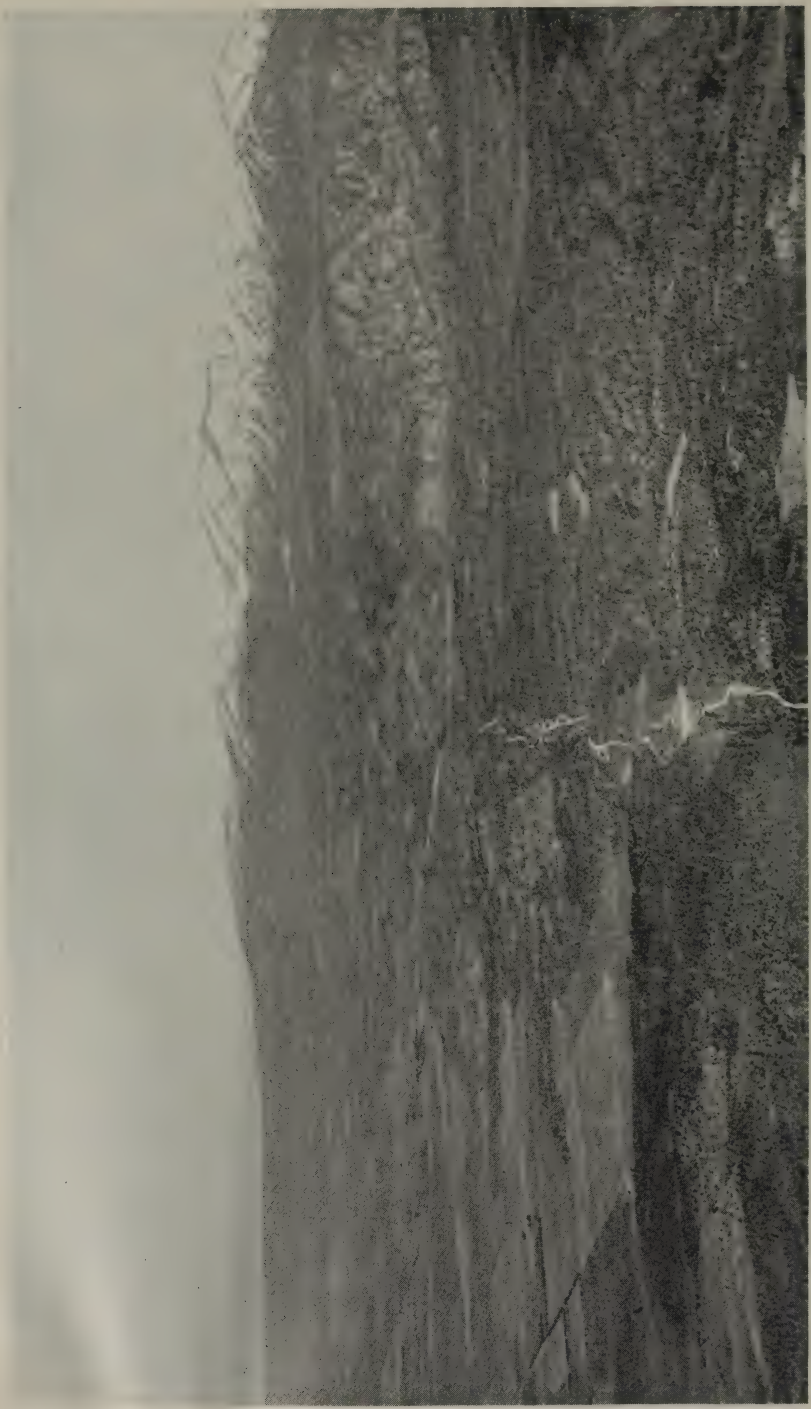

FIG. 13. Looking southeast along the San Andreas rift from a position above Palmdale; Little Rock Creek in the foreground.

High up on the flank of the Tehachapi Mountains the Oak Creek Canyon fault runs a course parallel to the Garlock fault. Its course is marked by a well-defined rift valley from its junction with the San Andreas rift near Gorman till it joins the Garlock fault a few miles north of Mojave. It is a system of two more or less parallel faults a quarter to a half mile apart, separated by a strip of badly crushed schist and limestone. The fault plane is vertical or nearly so. The throw is at least 2000 feet, for the north side towers abruptly by that amount over the country south of the fault. The rocks on opposite sides of the fault are very different, too, suggesting lateral displacement, probably of great magnitude.

The Sierra Pelona block is bounded on the north by the Bouquet Canyon and Bee Canyon faults, on the east by the San Andreas rift, and on the south by the Pelona fault. The Bouquet Canyon fault runs a course due west from its junction with the San Andreas, characterized by prominent rift valleys—Bouquet Canyon, Cherry Canyon, and Clearwater Canyon—and continues an unknown distance into the Tejon quadrangle. Along the Bouquet Canyon fault, the Sierra Pelona block is bounded by granitic rocks; along the Bee Canyon fault, by Martinez sandstone and shale. Both faults appear to have vertical or steep dips. On the south side, along the Pelona fault, the block is in contact with granitic rocks along most of its course. Near the western border of the quadrangle, however, in Texas Canyon, Escondido sandstones bound the fault on the south. The plane of the fault is steep or vertical except in Texas Canyon, where it dips about 60° south. The displacement along these faults can not be measured, but it is judged to be at least several thousand feet. An estimate of the age of the faults involved in the uplift of the Sierra Pelona block can be based on the age of the rocks in which detritus of Pelona schist first appears. Neither the Escondido nor the formations older than it contain any Pelona schist detritus. Pliocene rocks are missing, but the Quaternary bench gravels are largely made up of schist fragments. Late Tertiary or early Quaternary is thus indicated as the minimum age of the faults.

Two low angle thrust faults exist near the Pelona block, one on the north side near its western end, and one on the south side at its eastern end. Both dip 15° to 20° north. It seems likely that they were generated at the same time. The best known of them is the San Francisquito fault whose trace is visible for some 10 miles in San Francisquito Canyon below its junction with Bee Canyon. Escondido sandstones and shales have been thrust an unknown distance over Pelona schists. The thrust fault is cut off on the north by the Bee Canyon fault. Its age is thus younger than the Escondido formation which is involved in the thrusting and older than the Bee Canyon fault; therefore, late Miocene or Pliocene. The other thrust fault is visible for 3 miles on the southeast flank of Sierra Pelona, its eastern limit about a mile south of Harold Reservoir. Granite rocks have been thrust over the lavas of the Escondido formation. The contact is conspicuous by reason of a thick zone of pulverized rock, bleached white by weathering. At its eastern extremity the fault becomes a vertical fault, and for over a half mile it runs a course due east until it is hidden under the alluvium of Anaverde Valley. At its western extremity it is cut off by a vertical fault, an off-shoot of the Pelona fault.

The Rosamond fault forms the southern boundary of the Rosamond Hills block and the northern limit of Antelope Valley. From the northern shore of Rosamond Dry Lake its trace runs due west along the foot of the hills marked by numerous springs to the village of Willow Springs; from there, changing direction to N. 77° W., it continues for six miles toward the Tehachapi Mountains, marked by a definite scarp in the alluvial fan. It constitutes a marked break in the topography. North of the fault, bed-rock is at or close to the surface; south of it, bed-rock is deeply buried, in one place at least, over 2000 feet. The minimum vertical displacement in the vicinity of Willow Springs, estimated as the difference in elevation of the summit of Willow Springs Mountain and its base, is about 800 feet, but the actual displacement may be several times that. It is a normal fault, dipping south at an angle of about 75°. At its eastern end, basalt dikes fill fissures parallel to and adjacent to the present trace of the fault; and on Tropico Hill and at the base of Willow Springs Mountain auriferous quartz veins occupy fissures within the zone of rifting. As the dikes and veins are considered to have originated during the vulcanism of Rosamond time, they are taken to be evidence that the Rosamond fault was active then.

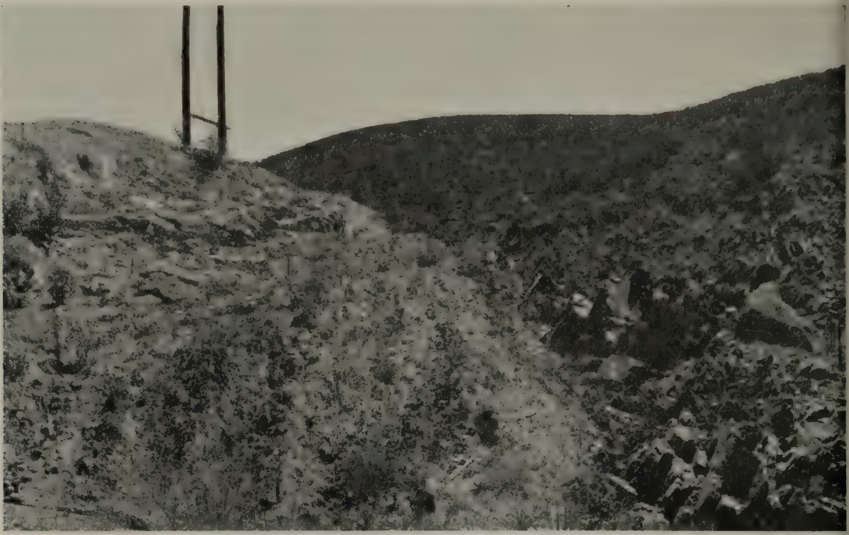

FIG. 14. Bouquet Canyon fault where it crosses the divide between San Francisquito and Bouquet Canyons. Pelona schist on the right, Martinez (Eocene) sandstone on the left.

All of these faults except the low angle thrust faults exhibit unmistakable signs of recent activity. The evidence is most plain in the case of the San Andreas, the Garlock, the Oak Creek Canyon, and the Rosamond faults; less plain in the case of the Bouquet Canyon, Bee Canyon, and Pelona faults. The region, therefore, is still seismically active, and continued faulting is to be expected along the planes already established.

MINERAL RESOURCES

Gold.

Both placer and gold mining have existed for the past eighty years in this quadrangle though very few of the mines have proved to be profitable ventures. The first gold discovered in the region was in the placer deposits in the vicinity of Newhall in 1834. These were worked by the padres of the San Fernando mission and their successors for about forty years. They found auriferous gravel in all the canyons that drain the San Gabriel Mountains, and by 1850 placer miners were working in San Francisquito, Texas, and Mint Canyons in this quadrangle. At that time at least one lode mine was being exploited in the southern part of the quadrangle. In 1894 gold was discovered on Soledad Mountain in the northern part of the quadrangle and for 15 years it was the scene of great activity. The district was abandoned for the most part when the easily accessible ores of the zone of oxidation were exhausted.

Red Rover Mine.

This mine comprises four claims in the Cedar Mining District, four miles north of Acton, in Secs. 22, 23, T. 5 N., R. 13 W. It was first worked by Mexicans from about 1850 to 1880, and then sporadically by Americans up to several years ago when it appears to have been definitely abandoned. The ore occurs in quartz veins traversing quartz diorite. The mine is developed by two shafts 400 feet deep and several thousand feet of tunnels. It is reputed to have produced a large tonnage of ore averaging about $10 a ton.

Bibl: Cal. State Mineralogist's Repts. VIII, p. 333, 1888; IX, p. 201, 1889; XI, p. 246, 1891–92; XII, p. 153, 1893–94; XIII, p. 204, 1895–96; XV, p. 476, 1915–16; XXIII, p. 295, 1927.

New York Mine.

This mine comprises three claims in the Cedar Mining District, three miles north of Acton, in Sec. 20, T. 5 N., R. 13 W. The gold occurs in quartz veins in quartz diorite. It is developed by a number of tunnels and a winze 100 feet deep. It has been worked intermittently since the early '80's. Only assessment work has been done on it in recent years. No production figures are available though they are believed to be small.

Bibl: Cal. State Mineralogist's Repts. IX, p. 192, 1889; XV, p. 476, 1915–16; XXIII, p. 294, 1927.

Double Eagle Mine.

This mine consists of six claims in Sec. 21, T. 6 N., R. 14 W., on the Bouquet Canyon road. The gold occurs in a number of quartz veins in quartz monzonite. The mine is developed by several short shafts and tunnels. The ore from surface workings is said to have run $8 to $10 a ton in gold, with much lower values in the deeper workings. The production was small. It has been idle for the last three years.

Bibl: Cal. State Mineralogist's Rept. XXIII, p. 293, 1927.

Mojave Mining District.

The Mojave Mining District, in which gold was discovered in 1894, contains the following productive mines:* Queen Esther, Exposed Treasure, Karma, Elephant, Echo, and Gray Eagle. These mines, with the exception of the Exposed Treasure, are located on the north side of Soledad Mountain, about four miles south of Mojave. The Exposed Treasure is located on a hill one mile north of Soledad Mountain. Interest in this district waned when the more accessible ore of the oxidized zone was exhausted. It was revived for a while by the discovery of high grade ore in a small butte northwest of the Exposed Treasure Mine, which led to the development of the Yellow Dog Mine. Work on this mine was abandoned when the small rich shoot was worked out.

FIG. 15. Soledad Mountain seen from a point four miles south.

The yield of the largest producer, the Exposed Treasure Mine, was over $2,000,000 up to 1928. None of the others except the Queen Esther appear to have been large producers. (See map, page 416.)

The gold occurs in a series of north and northwest trending quartz veins that traverse dacite flows and plugs. The veins occupy fault fissures of moderate displacement, usually a few tens of feet. There does not seem to have been any displacement since the veins were formed. The veins measure 5 to 20 feet wide. The ore shoots are said to have been small and irregularly distributed in the veins, causing their discovery to be largely a matter of chance and their exploitation usually an expensive business. Considerable silver was associated with the gold, and in some shoots constituted the main value. It occurred as cerargyrite very finely disseminated through the quartz above the water-table, changing in depth to argentite. The gold occurred free above the water-table, and is said to be associated with pyrite below.

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* Since the above was written, there has been opened up on the west side of Soledad Mountain, a gold-bearing vein in the Silver Queen claim. See description by W. B. Tucker, district mining engineer, on pp. 316-317, herein, *ante.*—W. W. B., Dec. 10, 1934.

In the Exposed Treasure, the only mine that has penetrated much below the water-table, the gold is found associated with chalcopyrite, bornite, sphalerite, galena, and argentite. In this mine the gangue minerals are not only quartz as in the other mines, but also chalcedony and calcite. According to De Kalb, the gold in this mine has been found to be an alloy containing one part of gold to 0.461 parts of silver.

The veins traverse dacite probably of Middle Miocene age. They would seem to represent a late stage of the same vulcanism that produced the Rosamond volcanic rocks, and therefore, to have originated during the late Miocene or Pliocene epoch. The thickness of Rosamond rocks that has been stripped off in this locality is probably not more than 3000 feet, which indicates that the veins were formed under epithermal conditions.

The mines of this district were all idle in 1928. During the last three years, however, some exploration work has been done in the Echo, the Gray Eagle, and the Yellow Dog Mines.

Bibl: Bateson, C. E. W., The Mohave mining district: Am. Inst. Min. Eng., Tr. 37, pp. 160–177, 1906. De Kalb, Courtenay, Geology of the Exposed Treasure Lode, Mohave, Cal.: Am. Inst. Min. Eng., Tr. 38, pp. 310–319, 1907. Cal. State Mineralogist's Rept. XXV, pp. 24–56, 1929. (For information about individual mines.)

Placer Deposits.

Placer deposits exist in this quadrangle on the southern slope of the Tehachapi Mountains and in the canyons and bench gravels of the southwest slope of the San Gabriel Mountains.

In the Tehachapi Mountains gold is found in the stream and bench gravels of the upper part of Bean Canyon. No water is available for working the gravel, but several miners have been able to eke out a bare living with the help of various dry concentrating devices.

Gold has been found in all the stream and bench gravels of the canyons that drain the southwest slope of the San Gabriel Mountains, notably in Bouquet, Texas, and Mint canyons. The placers were first worked by the padres of San Fernando mission in the early part of the last century, and have been worked on a small scale continuously up to the present. The largest auriferous gravel deposits are the terrace gravels that cover the wide flat interfluves between Texas and Mint canyons in the southwest part of the quadrangle. They are also the most inaccessible for the gravel is 100 to 750 feet above the canyon bottoms. The stream gravels, as well as the terrace gravels, are difficult to work, because of the exceeding scarcity of water except in the rainy season. Moreover, the gold is mostly fine-flake gold, rather hard to recover, though the miners working there now report having found considerable coarse gold. In spite of the difficulties, several generations of miners have made a modest living from these placers.

Graphite.

Graphite is of common occurrence in the granitic rocks of the San Gabriel Mountains in a belt about eight miles wide that borders the Sierra Pelona on the north. This belt is characterized by numerous areas of granitized and partially granitized schists, which strike east-west to northeast and have a steep or vertical dip. The graphite 'veins' are part of these granitized schists and are believed to have been formed through the metamorphism of carbonaceous sediments. The granitized schists with which they are associated show a rude orientation of the dark constituents in the original plane of bedding, but are otherwise normal granitic rocks. The graphite is crystalline, in flakes usually under a half-millimeter in diameter, and is associated in the 'veins' with the usual constituents of a granite.

The more important deposits occur in Bouquet and Elizabeth Lake canyons. A large number of claims have been located on a 'vein' that strikes northeast across Secs. 11 and 12, T. 6 N., R. 15 W., in Bouquet Canyon, maintaining a width of about eight feet for more than a mile, and traceable for a mile and a half. It dips vertically or steeply to the northwest. This deposit has been worked at intervals over a period of twenty-five years. At one time the California Graphite Company mined and milled ten tons a day. The enterprise did not prove successful due to difficulties in concentrating the ore. In 1931 the property had been abandoned for several years. The U. S. Geological Survey determined the percentage of graphite in samples collected from this property by E. S. Bastin. Its determinations are given below:

Sample	*Percentage of graphite*
Composite sample of graphitic schist from many different localities on Prince No. 1 claim	7.29
Composite sample taken at intervals of about 1 foot across 50 feet of graphitic schist exposed in cross-cuts in tunnel on Prince No. 4 claim	12.00
Sample of richest type of graphitic schist from same tunnel as No. 2	17.48

A large number of claims are located on graphite 'veins' that are exposed in the northwest wall of Elizabeth Lake Canyon from Hughes Lake southwest to beyond the limit of the quadrangle. These 'veins' strike northeast and have a vertical or steep dip, and though not linearly continuous, are believed to represent a single horizon of graphite schist. The 'vein' swells and pinches along its strike and in some places can be traced for many hundreds of yards; in others it apparently has pinched out for other hundreds of yards. For long distances the vein is more than twenty feet wide. The ore is high-grade in places, and averages much better than that in Bouquet Canyon. So far, no attempt has been made here to do more than development work.

Bibl: U. S. Geol. Survey Mineral Resources, pt. 2, pp. 164–165, 1914. Cal. State Mineralogist's Report XV, pp. 502–504, 1915; XVII, pp. 318–319, 1920; XXIII, pp. 325–326, 1927.

Building Stone.

Flagstone.

The Pelona Schist is being quarried at several localities in Bouquet and Francisquito canyons. The schists of almost the entire series have the property of being easily split up into thin slabs up to ten feet broad. The commonest varieties are gray quartz-mica-plagioclase schist and greenstone schist. Both are very hard when fresh.

Fresh exposures of the schist capable of being quarried occur for ten miles in the lower part of Bouquet Canyon and for several miles in San Francisquito Canyon in the vicinity of Municipal Power House No. 2. Good highways run through both of these canyons.

Bibl: Cal. State Mineralogist's Rept. XXIII, pp. 331–332, 1927.

Basalt Roofing Material.

Two quarries have been established on outcrops of basalt of the Escondido formation on the south side of the San Andreas Rift Valley between Harold Reservoir and Little Rock Creek. The basalt has been locally altered to a brilliant green color probably due to the agency of hot springs. It is this altered basalt, known to the trade as 'greenstone,' that is quarried and ground to a coarse sand for use in the manufacture of fireproof roofing. One quarry is in the SW¼, Sec. 21, T. 5 N., R. 11 W., and the other in the SW¼, Sec. 19, T. 5 N., R. 11 W. Both were idle when visited in 1931.

Bibl: State Mineralogist's Rept. XXIII, p. 332, 1927.

Marble.

Crystalline limestone or marble forms a prominent escarpment on the lower slope of the Tehachapi Mountains in this quadrangle. It is part of the same belt that is extensively mined for use as cement at Monolith, a few miles to the north. Rock of this belt was formerly quarried in Sec. 2, T. 9 N., R. 17 W., twelve miles west of this quadrangle, and the rock shipped to Los Angeles and San Francisco for use as building stone. The quarry has been idle for many years.

There is an immense amount of crystalline limestone in this belt. It has remained unexploited in this quadrangle because of its comparative inaccessibility (being four miles from the nearest road over rugged country) and lack of water.

Bibl: Cal. State Mineralogist's Rept. XXV, p. 73, 1929.

Feldspar.

Feldspar has been mined on two claims in the SW¼, Sec. 6, T. 9 N., R. 12, W., two miles northwest of Rosamond. The deposit is known as the Townsend Feldspar and Silica Deposit. The feldspar is mined from a wide pegmatite dike that strikes N. 60° E., through quartz monzonite. It is pink orthoclase for the most part, often graphically intergrown with quartz. White albite feldspar is present in only minor amount. The crushed rock is sorted by hand. A large tonnage has been shipped from this deposit in recent years, but the property was idle when visited in 1931.

The feldspar resources of this region are large. The quartz monzonite of the Rosamond Hills is traversed in many places by broad pegmatite dikes whose chief component is orthoclase. These dikes form prominent ridges and knolls in the granitic terrain. They are near highways and railroads and need only a market to make them worth exploiting. The most prominent of these dikes forms the backbone of the low eastward-trending range of hills three miles north of Rosamond Dry Lake. Prominent pegmatite dikes also occur in the quartz monzonite of the Antelope Buttes.

Bibl: Cal. State Mineralogist's Report, XXV, p. 65, 1929.

Gypsum.

The gypsum deposits in this quadrangle occur in a gypsiferous shale member of the Escondido formation. This member can be traced in the San Andreas Rift Valley for more than eight miles east of Palmdale. It varies in thickness from 50 to more than 200 feet, and lies between beds of sandstone and conglomerate. The beds strike N. 65° W. and dip steeply to the northeast. The gypsum occurs in thin beds usually less than an inch thick, alternating with equally thick layers of chocolate-brown shale. Locally, gypsum occurs in irregular beds two to four feet thick, that lie unconformably upon gypsiferous shales and sandstones. These are believed to have been deposited by the evaporation at the surface of groundwaters that have leached gypsum from the underlying rocks. The rock so formed is massive, very finely-crystalline and rather porous. It is yellowish in color from clay and iron-oxide impurities. Ths gypsiferous strata of the underlying rock all contain more or less clay impurity and are also stained yellow with iron oxide. Their gypsum is very fine-grained and has a fibrous habit. A partial analysis by the U. S. Geological Survey of typical specimens of both types is given below.

Partial Analysis of Gypsite from Alpine Plaster Company's Deposit, Palmdale, California. (Efflorescent Gypsum)

Lime (CaO)	32.8
Sulphur trioxide (SO_3)	45.3
Water driven off at 60° C.	.1
Water driven off at 300° C.	20.5
Chlorine (Cl)	.06
Iron oxide (Fe_2O_3)	.30

Partial Analysis of Rock Gypsum from Palmdale, California

Lime (CaO)	27.5
Sulphur trioxide (SO_3)	33.5
Water driven off at 60° C.	.8
Water driven off at 300° C.	15.6
Chlorine (Cl)	Trace
Iron oxide (Fe_2O_3)	1.3

George Steiger, analyist.

A dozen or more quarries were established on these deposits within two miles of Palmdale when the thick surface beds were available. These have now been either removed or are covered by too thick an overburden of alluvium to be mined profitably. Since the gypsiferous shales reached the unprofitable stage, the quarries and the plaster factories in Palmdale have closed. In 1931 they had been idle for several years.

Bibl: Hess, F. L., A reconnaissance of the gypsum deposits of Calif., U. S. Geol. Survey, Bull. 413, pp. 29–31, 1910. Cal. State Mineralogist's Report XI, p. 248, 1891–92; XII, p. 324, 1893–94; XIII, p. 504, 1895–96; XV, pp. 504–506, 1915–16; XXIII, p. 327, 1927.

Magnesite.

Magnesite occurs in thin beds ranging from mere seams up to 4 feet thick, interbedded with clays, cherts, and limestones of the Rosamond formation in the NE¼, Sec. 11, T. 10 N., R. 11 W., three-quarters of a mile north of Bissell station on the Santa Fe Railroad. The beds strike east-west to N. 65° W. and dip about 45° S. A typical section of the deposit is described by Gale in the work cited below, p. 513, and is reproduced below.

Section at 14-foot shaft near west end of Bissell prospects

	Ft.	In.
Cherty layer		6
Clay, carbonaceous, lenticular, about		4
Magnesite, white, about		5
Clay, gray, about		3
Magnesite, white, about		6
Clay, dark grey		4
Magnesite, white		4
Clay, white (Magnesite)?		8
Magnesite, clear white, massive	1	6
Clay, brown		4
Magnesite, white, about	1	
Clay, greenish, about		3
Magnesite, compact white		10
Clay (considerable body)		
	7	3

The following analyses are taken from the same work, p. 514.

Analyses of samples of magnesite from Bissell, California
J. G. Fairchild, analyst

	1	2	3	4
SiO_2	9.64	8.51	6.03	4.75
$Al_2O_3 + Fe_2O_3$	2.46	2.94	1.40	.76
CaO	4.25	3.36	1.56	Trace
MgO	37.19	38.32	42.78	44.20
CO_2	40.70	40.12	45.78	47.32
Undetermined	5.76	6.75	2.45	2.97
	100.0	100.0	100.0	100.0

To the east and south the rocks in which the magnesite occurs are covered with alluvium, so that the possible extension of this deposit is unknown in these directions. The magnesite beds pinch out westward and do not appear in the prominent occurrences of the Rosamond formation a half-mile to the west.

The deposit is peculiar in that it is sedimentary, forming part of a series of undoubted lacustrine sediments. It is probably a chemical precipitate resulting from the introduction of spring waters containing Epsom salt in solution into lake waters charged with CO_2.

The deposit has been thoroughly prospected and is held by a number of mining claims. There has been a small production. The properties were idle when visited in 1931.

Bibl: Gale, H. S., Magnesite deposits in California and Nevada: U. S. Geol. Survey, Bull. 540, pp. 512–516, 1916. Bradley, W. W., Magnesite in California: Calif. State Min. Bur. Bull. 79, pp. 47–50, 1925. Cal. State Mineralogist's Report XXV, p. 73, 1929.

Road Material.

Good road material is furnished by the widespread basalt and dacite deposits of the quadrangle. Dacite, especially, has been used extensively in making the roads of the region, as it is more accessible than the basalt. It has been quarried for this purpose on the north side of Soledad Mountain; in the Rosamond Hills one and a half miles north of Rosamond; at Willow Springs; and at Red Hill, three miles east of Rosamond. At Red Hill the rock is quarried in fragments already of the proper size from the thick talus apron at the foot of the hill.

Quartz.

Quartz is mined at Quartz Hill, five and a half miles southwest of Lancaster, from a vein 75 feet wide. The vein trends east-west through Pelona schist, forming the backbone of the hill for a quarter of a mile. The quartz is white and high grade. A large tonnage has been shipped to Los Angeles for use in the manufacture of pottery and silica ware.

Quartz veins or 'blow-outs,' as they are known locally, are of common occurrence in the Pelona schist terrain. Many of the veins are more than twenty feet wide but are at present worthless because of their inaccessibility.

Bibl: Cal. State Mineralogist's Report XV, p. 513, 1915–16.

Talc.

Talc occurs as dikes and sills in many places in the Pelona schist terrain. These range from a few inches to over 20 feet in thickness, and in linear extent from a few yards to more than a quarter mile. The talc is fine-grained, apple-green in color, and in many places is intergrown with actinolite, which ordinarily occurs as nests in the talc, but in some places the talc passes laterally into actinolite. The talc-actinolite dikes and sills are believed to have resulted from the metamorphism of peridotite intrusive bodies.

A small amount of talc has been mined from a dike that courses across the southwest corner of Sec. 6, T. 5 N., R. 13 W. This deposit is too deeply colored and contains too much actinolite to be of much value. A large number of claims have been located on talc dikes that traverse the schists of the northwest wall of Bouquet Canyon. Other talc deposits in the bottom of the canyon have been revealed by recent road cuts. It is all too green in color to be considered first grade. None of the deposits were being worked in 1931.

Bibl: Cal. State Mineralogist's Report XVII, p. 321, 1920; XXIII, p. 329, 1927.

Clay.

A large amount of pottery clay has been quarried from a deposit in the SE. $\frac{1}{4}$ Sec. 11, T. 9 N., R. 13 W., four and a half miles northwest of Rosamond. Two quarries have been established on a low-dipping bed of clay 300 feet thick, interbedded with dacite flows of the Rosamond series. The deposit is a slightly altered rhyolite-pumice tuff, and is stated to be a pottery clay of good quality. In 1931 the quarries had been idle for several years.

Arsenic.

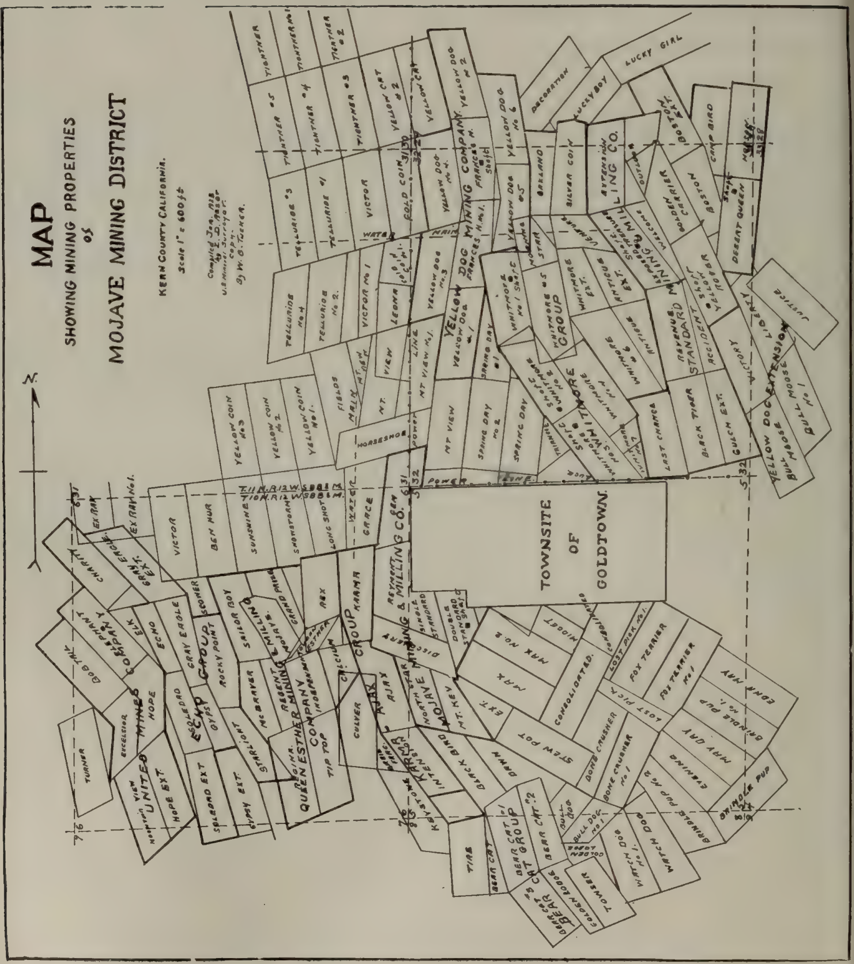
Arsenic ore occurs in several places in the contact zone of limestone and quartz monzonite on the south flank of the Tehachapi Mountains. Several claims have been located on these deposits in Sec. 10, T. 10 N., R. 15 W. The ore is arsenopyrite associated with pyrite, and occurs in small irregular veins six to twelve inches wide in limestone. No ore has been shipped, and in 1931 the prospects were idle.

Bibl: Cal. State Mineralogist's Report XXV, p. 22, 1929.

Petroleum and Natural Gas.

There has been considerable exploration for petroleum and natural gas in this quadrangle, but none has been found. A boring for oil in the northwest quarter of Sec. 23, T. 8 N., R. 13 W., in the middle of Antelope Valley, pierced 2100 feet of alluvium without a showing of oil or gas. Another bore, at the mouth of Cottonwood Creek, in the SW$\frac{1}{4}$, Sec. 11, T. 10 N., R. 15 W., passed through 3300 feet of alluvium and then through 800 feet of quartz diorite with no sign of oil or gas. Another, one-half mile north of Willow Springs, struck granite at 150 feet.

The rocks that crop out at the surface are representative of the types that underlie the alluviated parts of the quadrangle. These rocks are of two main types, granitic and metamorphic rocks that form the crystalline basement, and Tertiary and Quaternary continental sediments and volcanic rocks. The crystalline rocks are by their nature incapable of yielding petroleum deposits. The Tertiary and Quaternary rocks are extremely poor in organic matter that could conceivably be converted into petroleum. There are no surface indications of oil or gas in these rocks. It is therefore considered most improbable that petroleum or natural gas will ever be found in the rocks of this quadrangle.


MAP
SHOWING MINING PROPERTIES
of
MOJAVE MINING DISTRICT
KERN COUNTY CALIFORNIA.
Scale 1" = 600 ft.
Compiled Jan. 1915 by L. D. Aslop U.S. Mineral Surveyor. Copy. By W. B. Tucker.
N.
TOWNSITE OF GOLDTOWN
YELLOW DOG MINING COMPANY
YELLOW DOG EXTENSION
WHITMORE GROUP
STANDART MINING CO.
QUEEN ESTHER MINING COMPANY
MOJAVE MINING & MILLING CO.
KARMA GROUP
CAT GROUP
UNITED MINES COMPANY
ECHO GROUP
REGENT MINING CO.
TIGHTNER
TELLURIDE
YELLOW COIN
VICTOR
BEN HUR
SUNSHINE
SNOWSTORM
LONG SHOT
GRACE
HORSESHOE
MT. VIEW
SPRING DAY
LAST CHANCE
BLACK TIGER
GULCH EXT.
VICTORY
BULL MOOSE
JUSTICE
LUCKY GIRL
LUCKY BOY
DECORATION
CAMP BIRD
DESERT QUEEN
BOSTON
SILVER COIN
MAX
FOX TERRIER
CONSOLIDATED
LOST PICK
STEW POT
BONE CRUSHER
MAY DAY
EVENING
WATCH DOG
BULL DOG
TOWSER
BEAR CAT
TIRE
DAWN
BLACK BIRD
KEYSTONE
REX
CALCIUM
CULVER
TIP TOP
STARLIGHT
GYPSY EXT.
SOLEDAD EXT
HOPE EXT.
TURNER
HOPE
ELK
GRAY EAGLE
VICTOR
EX RAY
T.11 N.R.12 W. S.B.B.&M.
T.10 N.R.12 W. S.B.B.&M.
POWER LINE
WATER MAIN

GEOLOGIC FEATURES OF THE DRY PLACERS OF THE NORTHERN MOJAVE DESERT

By CARLTON D. HULIN *

In the last several years considerable interest has been exhibited in the dry placers of the Mojave Desert. While the more productive placers were largely worked out in early years, the recent rejuvenation of interest in gold mining has resulted in an influx of prospectors so that in many of the better known and more accessible dry placer districts scores of men may now be found sinking shafts and operating dry concentrating machines.

Whatever the economic future for these operations may be, some little interest attaches to the origin of the gold of these dry placers. Widely scattered as they are throughout the desert province, if the gold be of local origin as is commonly believed by many of the prospectors and miners, primary gold deposits would be expected to be as common and as widely scattered as are the placers. Actually this is not the case, and in certain areas intensive prospecting of the country tributary to productive dry placers has proven entirely fruitless.

During recent years the writer has been engaged in studying and mapping the geology of the Searles Lake quadrangle, an area of 3886 square miles located in the northern part of the Mojave Desert province. In the course of this work particular attention has been given to the geologic setting of the various primary metalliferous deposits and also of the various placer deposits which have been encountered in the area so far studied. Work on the Searles Lake quadrangle is still incomplete and in consequence it is not feasible at this time to indicate areas which may be particularly attractive to prospectors; nevertheless the work has advanced sufficiently far as to indicate clearly that two distinct types of placer deposits occur in this region, and the more important factors involved in the origin of each type have been worked out.

Although the work done by the writer has been confined to the Searles Lake quadrangle, it is believed that the placer gold occurrences of surrounding portions of the Mojave Desert are entirely comparable to those of the area which has been studied.

It is believed that a discussion of the origin of these placers will be not only of scientific interest but of direct assistance to prospectors and miners of the desert province as well.

An understanding of the origin of the placer gold deposits calls for a knowledge of the later geologic history of this region. The earlier geologic history will be touched upon only briefly.

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General Geology

During the Paleozoic the Searles Lake region was receiving more or less continuous deposition of marine sediments. A thick sedimentary column was thus built up, its members ranging in age probably from Algonkian to Permian, and including all of the more common types of sediments—conglomerates, sandstones, shales, limestones and cherts.

Little is known concerning the history of the early Mesozoic. A sequence of lavas is known in the extreme eastern portion of the area which is ascribed to the Triassic or Lower Jurassic. Similar lavas are also known elsewhere in surrounding portions of the Mojave Desert.

In the Middle Mesozoic, at the end of the Jurassic or the beginning of the Cretaceous, occurred the great Sierra Nevada batholithic invasion. The Sierra Nevada of that time can hardly be pictured as being even similar in extent to the present Sierra, since the batholithic invasion involved not only much of the area of the present Sierra Nevada but an almost equally great area in the Tehachapi Mountains and in the desert ranges to the east and south of the present Sierra.

The physical relief of the Searles Lake region at the time of the batholithic invasion can not as yet be reconstructed on the basis of any direct evidence. It may well have been mountainous, but if so its mountainous character was not particularly due to folding. The Paleozoic strata, where folded, show a rather open type of folding; elsewhere the pre-batholithic rocks are nearly flat-lying and may show but little evidence of disturbance. Effects of dynamic metamorphism are in general rather weak in the Paleozoic rocks, though thermal effects, particularly close to the contacts with the granitic rocks, may sometimes be quite pronounced.

The plutonic rocks composing the batholith in the Searles Lake quadrangle are usually rather coarsely granitic in texture and possess a general composition of quartz monzonite, though more acid and more basic variants are known. Cutting the quartz monzonite with extreme abundance are innumerable dikes of aplite, and less commonly pegmatite dikes and dikes or pipes of lamprophyric character are encountered. The lamprophyres in general have the composition of hornblendeite and are typically of extremely coarse grain.

Eocene(?) Intrusives

A second and later group of dikes is encountered in a number of isolated areas in the Searles Lake quadrangle. Within rather sharp areal limits the dikes of this second group may be very abundant, while beyond the limits of each specific area they appear to be entirely absent. The dikes of this group can be naturally subdivided into more acidic members, light in color and poor in ferromagnesian constituents, and into dark-colored ferromagnesian-rich members of lamprophyric type. The dark lamprophyric dikes cut the light-colored acid dikes. Dikes of both types tend to be prophyritic in habit, and possess fine-grained ground-mass textures, the lamprophyric type tending however to be coarser grained than the more acid members.

Dikes of this group are clearly set apart on textural grounds from the older aplites, pegmatites and coarse-grained lamprophyres which are related to the Sierra Nevadan quartz monzonite invasion. The fine-grained groundmass texture of this later group of dikes indicates rather rapid cooling and hence injection into cool wall rocks. Hence they must be distinctly later than the late Jurassic granitic rocks.

These dikes can be demonstrated as being pre-Middle Miocene, since they are locally capped with Middle Miocene sediments. In age then the dikes may be anything from Lower Cretaceous to Middle Miocene. Tentatively, however, they will be classed as early Eocene and comparable to the supposed early Eocene intrusives known through central and eastern Nevada and western Utah, although this can not as yet be directly demonstrated on field evidence.

Subsequent to the batholithic invasion at the close of the Jurassic or the beginning of the Cretaceous the Searles Lake quadrangle and adjacent areas were subjected to more or less continuous erosion until about the middle of the Miocene. Whatever the relief may have been at the beginning of the Cretaceous, by early Miocene time this relief had been worn down until the surface at least approximated a peneplain. The thickness of material removed by erosion during this lengthy interval can only be conjectured. To judge from the extent of the quartz monzonite now exposed, from ten to twenty thousand feet of rock may well have been eroded away. All of the products of this erosion were removed from the region so that a well-developed external drainage system must necessarily have been in existence. It has been possible to recognize only isolated local portions of this drainage system.

The Rosamond Series

In about Middle Miocene time the northern Mojave Desert region was affected by warping and faulting, with the resultant formation of elevated mountain blocks and depressed basins and a complete destruction of the pre-existent drainage system. Erosion attacked the elevated blocks, the detritus being deposited in the adjacent depressed areas. Of local origin, the detritus consisted dominantly of arkosic sediments derived from the abundant quartz monzonite, though locally detritus from the various Paleozoic and older horizons appears with abundance.

Thus was initiated the deposition of the Rosamond Series, of widespread occurrence in the northern Mojave Desert, though best known at Rosamond, south of Mojave, and in the Barstow syncline, north of Barstow.

The Rosamond sediments were accumulated under prevailing arid conditions quite similar to those existing in the region today. The localized depressed basins became temporary playa lakes into which sediments eroded from nearby hills were carried by cloudbursts, by soil creep, or by wind action. Owing to the usually short transportation involved, the sediments are typically angular, and we now find arkosic sandstones, angular arkosic conglomerates, clays, and occasionally even salines, variously interbedded in this lower part of the Rosamond series. The clays are frequently colored in shades of green, buff, red, brown or yellow and rather commonly are gypsiferous.

The sedimentation of the lower Rosamond was interrupted by a widespread volcanic outburst which apparently affected the whole desert province, and which can unquestionably be correlated with volcanic outbursts of other portions of the Great Basin. The opening phase of the volcanic activity was of the explosive type, and apparently the whole region was blanketed with a thick mantle of tuff. In the portions of the region which were topographically high at the time of the volcanic outburst, these tuffs are found resting directly on the quartz monzonite or upon the Paleozoic rocks. Traced into adjacent basins, however, pure tuffs are found resting directly upon arkosic sands and clays which contain no trace of volcanic detritus.

Locally the formation of this tuff horizon was accompanied and followed by the accumulation of agglomerates, the pouring out of lava flows, and the injection of dikes and plugs. The volcanic activity appears to have been of the fissure type, no central vents having been recognized, whereas dikes are commonplace and many times can be actually seen to feed flows.

The nature of the volcanic activity appears to have varied from time to time and from place to place, rhyolites, dacites and rather acidic light-colored andesites and their pyroclastic equivalents all being represented.

Following the time of volcanic activity, erosion continued but now the detritus deposited in the depressed basins consisted of admixed volcanic-arkosic materials, dominantly volcanic at the start, but becoming more and more arkosic with passing time. During this third phase of the Rosamond sedimentation the topographically high portions of the region probably had the tuffs completely stripped away except where interbedded or overlying lava flows served as a resistant protective covering.

The age of the middle and upper phases of the Rosamond series can be fixed as early Upper Miocene on the basis of vertebrate fossils occurring in the Barstow syncline. Insofar as the writer is aware, no fossils have as yet been found in the arkosic lower Rosamond. It is, however, continuous with the succeeding phases, and it appears probable that the base of the Rosamond is no older than the Middle Miocene. Until this is checked by actual fossil evidence, however, some slight doubt must exist as to the exact date of inception of the Rosamond sedimentation.

Upper Miocene Andesites

Rather widely distributed through the northern portion of the Mojave Desert, in areas ranging from a fraction of a square mile to tens of square miles, occur flows of basic, dark-colored andesites. These may rest on the Rosamond, or upon any of the basement rocks of pre-Tertiary age. Pebbles and boulders of these andesites occur in the basal portion of the next succeeding group, the Ricardo series of known Lower Pliocene age. The age of these andesites is thus fixed as being between the Rosamond and Ricardo, and hence as Upper Miocene.

The Ricardo Series

The Ricardo series is known to be of Lower Pliocene age on the basis of vertebrate fossils found at the type locality in Red Rock Canyon and its tributaries. While best known at Red Rock Canyon, the Ricardo series is as extensively developed in the northern Mojave Desert as is the Rosamond series. It is to be found in widely scattered localities throughout the Searles Lake quadrangle, and extends on into adjacent portions of the Mojave Desert.

At the beginning of Ricardo time the northern Mojave Desert appears to have been an area of low relief above which rose occasional hills and mountain groups, characterized by the resistant Upper Miocene volcanic rocks. The depressed basins which characterized the Rosamond sedimentation had been largely filled and the present mountain ranges in general had not come into being.

Into this region in early Ricardo time came a large river system which blanketed the lower portions of the country with stream gravels and conglomerates. The course of the stream can not as yet be entirely fixed, but in general it can be stated that it came in from the northward and sought an outlet towards the southeast in the general direction of the Colorado River.

The stream was dominantly depositing and the gravels and conglomerates left behind were of the nature of flood-plain deposits. Undoubtedly at first the stream sought the lowest channel available, but with passing time the earlier channels were filled with gravels and the stream crowded onto adjacent flat parts of the area. Isolated patches of these gravels are to be found widely scattered throughout the Searles Lake quadrangle, and originally a continuous blanket of gravels must have covered all of what was then the lower part of the area.

The basal conglomerates of the Ricardo series are of variable thickness. Poorly developed at Red Rock Canyon, they increase in importance eastward, reaching a thickness of over one hundred feet at Black Mountain. The conglomerates are sandy and poorly sorted and almost unconsolidated in most exposures. The individual pebbles and boulders are all highly rounded and for the most part range from one to two inches in diameter. Occasional horizons, however, show much larger boulders, several horizons being seen carrying perfectly rounded boulders in excess of a foot in diameter. The pebbles and boulders in general are composed of resistant rock types, the more common being various porphyries, granitic rocks, quartzite, chert and crystalline limestone. Many of these are unlike any rocks known in the Searles Lake region. Basalt pebbles and boulders are absent from the basal Ricardo conglomerates, thus distinguishing them from later gravel accumulations of the region.

The extent of the Ricardo gravels, their size range, their highly rounded condition, and the foreign nature of many of the rock types, are suggestive of deposition by a large stream of moderate grade originating in higher country many tens and possibly more than a hundred miles distant to the north, northeast or northwest.

The stream history of the lower Ricardo was shortly terminated by faulting and volcanic activity which disrupted and probably destroyed the pre-existent drainage system. In several portions of the region important accumulations of tuffs, with some interbedded arkosic sediments, agglomerates, and flows of andesite, showing a finely developed flow structure, overlie the basal conglomerates. These grade upwards into more basic tuffs and flows of olivine basalt. Elsewhere in the region, olivine basalt flows rest directly on the conglomerates, the intervening tuffs and andesites being absent.

While at many places the olivine basalt flows represent the present top of the sections exposed, at other places, particularly at Red Rock Canyon, the basalts are still to be seen interbedded in the sections and are overlain by vast thicknesses of poorly sorted arkosic sands and angular gravels which obviously have had a rather local origin.

Post-Ricardo Time

Following the final Ricardo sedimentation, faulting continued, blocks being shoved up (relatively) to give the present fault-block mountains of the region; other blocks subsiding and creating the depressed basin areas. Erosion has accompanied this later fault history (during the later Pliocene, Pleistocene and Recent), cutting into and lowering the mountain blocks and creating the present mountain topography, the detritus removed being carried into the depressed basins, gradually filling them.

In a number of places late Pliocene or Pleistocene gravels have been uplifted by later fault movements and are now undergoing dissection. Elsewhere changes in the power of the erosive agents or local changes in base level have likewise led to the dissection of these later gravels. The later dissected gravels are seldom to be confused with the older conglomerates of the basal Ricardo, since as has been pointed out the later gravels almost invariably carry numerous boulders of olivine basalt and such boulders are strictly absent from the basal Ricardo conglomerates.

During post-Ricardo time, down to the Present, the erosion which has gone on has occurred under strictly arid conditions. In the more elevated portions of the area bare rock exposures were attacked by the various erosive agents, the rock mass being broken down and loose detritus set free. These erosive agents have been quite varied and include not only the abrasive action of wind and running water, but also the effects of temperature change, both daily and annual; the action of freezing and thawing; and the effects resulting from chemical decomposition and hydration of minerals of the rock mass.

The loose detritus set free has continuously tended to move towards the depressed basin areas. In more exposed positions and on the open flats, wind action has been important in moving the finer detritus. In general, however, wind transportation has been of inferior importance as compared to other methods. Gravity has played a part on the steeper slopes.

Transportation by running water has, however, been the dominant mode of movement of detritus in spite of the aridity of the region. The high porosity of the desert soils and sands allows little run-off during normal rainfall, the rain sinking almost immediately into the ground. Occasionally, however, exceptionally heavy rains or cloudbursts occur and during these periods a very heavy run-off is produced. Thus during short periods of exceptional precipitation more detritus may be transported from the higher to the lower parts of the region than is moved during the months or even years that may intervene between cloudbursts.

Primary Metalliferous Deposits

Primary mineralization is known to have occurred during at least three distinct periods in the Searles Lake area. Each period of mineralization was related to a period of igneous activity, the mineralization occurring during the closing stages of such activity.

The first period of mineralization was related to the batholithic invasion of quartz monzonite at the close of the Jurassic. The mineralization of this time is not known to be economic in this area. Veins showing high temperature characteristics occur widely scattered. Usually narrow, a few veins were seen possessing thicknesses of ten to twenty feet. They cut any of the pre-Tertiary rocks and are later than the aplites, pegmatites and lamprophyres which represent the last phase of the batholithic invasion. The quartz of the veins is coarsely crystalline and glassy, and high temperature minerals such as epidote, orthoclase and micas are occasionally to be observed. Prospectors in general have learned to avoid these veins.

Some mineralization has also been locally developed along contacts of the batholith. An example of this in the El Paso Mountains shows minor pyrite and copper minerals in a rather strong contact silicate zone.

The second period of mineralization is related to the intrusion of the dikes which have been questionably assigned to the Eocene. One may travel for miles through country devoid of these dikes and devoid of any evidence of mineralization or of the activity of prospectors. One may then enter an area where the Eocene dikes are present and immediately abundant evidence of mineralization is apparent—usually made so by numerous abandoned prospect holes, shafts and tunnels. On leaving the area where dikes outcrop, the evidences of the former activity of prospectors are likewise left behind.

Regardless of theory, the coincidence of distribution of the dikes and mineralization strikingly indicates an evident relationship between the two.

The veins of this second period of mineralization are later than the dikes which they commonly follow or cut. The veins are usually narrow but sometimes swell out to thicknesses of four or five feet. They are of quartz and show features suggestive of both mesothermal and epithermal characteristics, dominantly the latter. While gold is the economic metal, the presence of pyrite, arsenopyrite, galena, sphalerite, chalcopyrite and molybdenite can be observed in various cases.

The veins of this period have in many cases been productive in a small way, and many are still being actively explored. These veins, however, while in many cases productive of high-grade ore, are inclined to be erratic and to pinch, swell or terminate with extreme suddenness. As a result in very few cases have actual orebodies of consequence been developed.

The third period of mineralization was related to the early Upper Miocene igneous activity of the Rosamond and gave rise to typical epithermal deposits of the bonanza type. The highly productive deposits around Randsburg, at Atolia, at Calico, and south of Mojave in Soledad Mountain are the best known. In the several cases the deposits are of value for gold, for silver, and for tungsten (scheelite). Formed at relatively shallow depths during Rosamond time, and initially possessing a limited vertical range, deposits of this type could easily have been destroyed by erosion if existing in areas subsequently uplifted. Or if formed in areas later depressed, deposits of this type may well exist in this region, unknown, due to burial and protection from erosion.

Placer Deposits

Two different modes of origin of placer gold deposits exist in the northern Mojave Desert region, as was intimated early in the paper. The first type of placer gold deposit has been derived directly from the erosion of nearby primary gold deposits. The value of placer gold deposits falling in this group would be dependent among other things on the richness (i.e. the amount of gold available) in the primary deposit; on the coarseness of that gold; on the amount of erosion the primary deposit had undergone; and on a topographic environment favoring the concentration of the gold removed by erosion as contrasted with one which would cause the eroded gold to become admixed with great quantities of valueless rock detritus.

Economic placers falling into this group which are known to the writer are limited to derivation from the bonanza deposits in the vicinity of Randsburg. On the north slope of the Rand Mountains near Randsburg, and on the south slope of the Rand Mountains in the Stringer District and south to below Atolia important dry placers were worked in the early days and a few are still being exploited. The gold in these occurrences was derived directly from the veins near Randsburg and from veins in the Stringer District. These placers carried not only placer gold but placer scheelite as well, and in recent years the scheelite content of the gravels in the placers south of Atolia has been vastly more valuable than the gold content.

Gold from placers near Randsburg examined by the writer was somewhat pale in color, typically angular, and not infrequently gold grains were still intergrown with fragments of quartz. These characteristics are directly the result of the very limited transportation which the gold of these placers has undergone.

Gold placers of this type but of subordinate importance may well exist in connection with the gold-bearing veins of the areas of Eocene mineralization. The writer knows of no case where such placers have been worked, but evidence of early-day small-scale operations might well have been completely destroyed in the intervening years.

The second type of placer gold deposit of this region resulted from the erosion and reworking of the basal conglomerates of the Ricardo Series with a resultant concentration of gold which was originally present in those conglomerates. The widespread distribution of the fluviatile conglomerates of the basal Ricardo has already been described. And in the area so far studied by the writer practically everywhere that these conglomerates outcrop in important quantity the gulches and washes leading from the outcrops either show evidence of dry placer operations in former years or are being actively exploited at the present day. Gold found in these placers, seen by the writer, is slightly darker in color than that found near Randsburg, and shows decided evidence of abrasion and rounding which indicate a lengthy transportation.

As examples to indicate the widespread distribution of placers of this second type of origin may be mentioned the placers formerly or now being worked in Jawbone, Red Rock, Last Chance and Goler canyons in the El Paso Mountains; Summit Diggings; old placer workings near Christmas Camp, southwest of Searles Lake; the Hamburger placer east of Fremont Peak; Opal Camp; Coolgardie and Williams

Well, north of Barstow; and at Indian Spring in the extreme eastern part of the Searles Lake quadrangle.

The original source of the gold carried by the basal conglomerates of the Ricardo Series is not known. It may well have been in the Sierra Nevada, far to the north or northwest; or it may have been from gold deposits occurring in the desert ranges east of the Sierras and north or northeast of the Searles Lake quadrangle.

No attempt has been made to determine the actual gold content of the basal Ricardo conglomerates, but it is undoubtedly quite low—probably only a cent or two a yard, if that. The concentration of gold found in the workable dry placers represents the results of reworking of immense quantities of the Ricardo conglomerates by erosional agents operating over a very lengthy period of time. As a result the concentration ratio giving rise to the present placers was at least several hundred to one.

As has been indicated the transportation of sedimentary detritus under the arid conditions existing in the northern portion of the Mojave Desert is done largely by flood waters during times of extreme precipitation. During intervening periods the canyons and washes gradually accumulate a detrital fill—sedimentary detritus washed in by the lighter rains and which the rain water is unable to carry further. This fill may accumulate to a considerable thickness before the next cloudburst. When this cloudburst comes it may sweep out all of the fill from the canyon, or it may carry away only part of it, depending on the intensity of the cloudburst and the depth of the fill. Quite obviously with excessive quantities of detritus available the flood waters will be badly overloaded and the concentration of placer gold will be extremely variable. Moreover the concentration during any given cloudburst will be at the bottom of the channel which existed for that particular cloudburst.

In consequence of these types of action the features of dry placers may be expected to be quite variable. While the best possibility for gold concentrations will always be on bed rock, other concentrations may occur at any horizon in the gravels. And these concentrations, on bedrock or otherwise, may be quite sharp; or the gold may be distributed through some given thickness of gravel.

Nor are all the placer gold concentrations to be found in the present gulches and washes. During the Upper Pliocene and early Pleistocene placer gold concentrations were forming just as they are today, and the bottoms of the canyons of that time were much higher than now and in many cases occupied different courses. With passing time these canyons were cut deeper and locally as this deepening progressed, portions of the old channel gravels were left behind. These are now found as terrace gravels perched high above the bottoms of the present gulches. Many such terrace deposits have been found and mined in Goler Canyon, in Last Chance Canyon, and in other localities in this region.

This paper was written as a progress report covering a portion of the results obtained to date in the study of the geology of the Searles Lake quadrangle. In consequence references, detailed descriptions, and details of geographic occurrence have been largely omitted.

Goler Canyon Placers—Goler Canyon Mining Co.

Photo by Walter Abel.

OIL FIELD DEVELOPMENT OPERATIONS

R. D. Bush, State Oil and Gas Supervisor

From April 1, 1934, to and including June 30, 1934, the following new wells were reported as ready to drill:

Company	Sec.	Twp.	Range	Well No.	Field
FRESNO COUNTY:					
The Texas Co.	35	20 S.	14 E.	1	Coalinga
Kettleman North Dome Assoc.	28	21 S.	17 E.	87	Kettleman North Dome
Kettleman North Dome Assoc.	30	21 S.	17 E.	32	Kettleman North Dome
Kettleman North Dome Assoc.	30	21 S.	17 E.	65	Kettleman North Dome
Kettleman North Dome Assoc.	34	21 S.	17 E.	61	Kettleman North Dome
Kettleman North Dome Assoc.	4	22 S.	17 E.	75	Kettleman North Dome
Standard Oil Co.	19	21 S.	17 E.	87	Kettleman North Dome
Standard Oil Co.	29	21 S.	17 E.	2	Kettleman North Dome
Standard Oil Co.	29	21 S.	17 E.	43	Kettleman North Dome
Standard Oil Co.	29	21 S.	17 E.	56	Kettleman North Dome
Standard Oil Co.	29	21 S.	17 E.	87	Kettleman North Dome
Standard Oil Co.	33	21 S.	17 E.	61	Kettleman North Dome
Union Oil Co.	29	21 S.	17 E.	King 7	Kettleman North Dome
G. E. Development Co.	36	16 S.	14 E.	1	
Mustang Oil Co.	8	21 S.	13 E.	1	
IMPERIAL COUNTY:					
John Barth	5	11 S.	16 E.	Barth 1	
Carl M. Einhart	12	11 S.	13 E.	7	
KERN COUNTY:					
Belridge Oil Co.	27	27 S.	20 E.	50-27	Belridge
Continental Oil Co.	36	27 S.	20 E.	Result 5	Belridge
Reward Oil Co.	34	27 S.	20 E.	5	Belridge
Barnsdall Oil Co.	26	30 S.	29 E.	Lawson 11	Edison
Barnsdall Oil Co.	26	30 S.	29 E.	Lawson 21	Edison
Barnsdall Oil Co.	26	30 S.	29 E.	Slininger 1	Edison
Barnsdall Oil Co.	27	30 S.	29 E.	Russel 1	Edison
A. T. Jergins Trust	14	30 S.	29 E.	Dougherty 1	Edison
Shell Oil Co.	15	30 S.	29 E.	Duff 2	Edison
Shell Oil Co.	16	30 S.	29 E.	Cauley 1	Edison
Cascade Oil Co.	23	29 S.	27 E.	Cascade 2	Fruitvale
General Petroleum Corp.	14	28 S.	27 E.	Young 4	Kern River
The Ohio Oil Co.	32	27 S.	27 E.	Midway Premier 2	Kern River
Standard Oil Co.	15	30 S.	22 E.	45	McKittrick
E. C. Arnold Oil Co.	34	31 S.	24 E.	4	Midway
Honolulu Oil Corp., Ltd.	14	32 S.	24 E.	32	Midway
Standard Oil Co.	11	32 S.	24 E.	19	Midway
Associated Oil Co.	30	27 S.	28 E.	Fortine 1	Mt. Poso
General Petroleum Corp.	21	27 S.	28 E.	Glide 21 18	Mt. Poso
Fred E. Keeler II	27	26 S.	28 E.	Keeler II-Salisbury 1	Mt. Poso
Modoc Petroleum, Ltd.	28	26 S.	28 E.	Johnson 2	Mt. Poso
Petroleum Drilling & Exploration Co., Inc.	21	27 S.	28 E.	Glide 1	Mt. Poso
Pongratz Petroleum Co.	10	27 S.	28 E.	Pongratz-Tavis 3	Mt. Poso
Shell Oil Co.	9	27 S.	28 E.	Vedder 11	Mt. Poso
Shell Oil Co.	16	27 S.	28 E.	Security 8	Mt. Poso
The Texas Co.	4	27 S.	28 E.	Alta Vedder 5	Mt. Poso
The Texas Co.	4	27 S.	28 E.	Alta Vedder 6	Mt. Poso
Two and One Oil Co., Ltd.	27	26 S.	28 E.	Two and One 5	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 11	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 12	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 13	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 14	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 15	Mt. Poso
Union Oil Co.	4	27 S.	28 E.	S. & M. 16	Mt. Poso
M. A. Fox	25	30 S.	28 E.	Fox Bristol 2	Mountain View
Gilmore-Snyder Co.	24	30 S.	28 E.	1	Mountain View
Hogan Petroleum Co.	29	30 S.	29 E.	Porter-Day 4	Mountain View
Hogan Petroleum Co.	32	30 S.	29 E.	Wharton 3	Mountain View
Otis Hoyt	19	30 S.	29 E.	Petrol 1	Mountain View
A. T. Jergins Syn., Inc.	30	30 S.	29 E.	Wright-Bloemer 1	Mountain View
A. T. Jergins Trust	24	30 S.	28 E.	Mullaney 1	Mountain View
A. T. Jergins Trust	24	30 S.	28 E.	Wallace 1	Mountain View
A. T. Jergins Trust	30	30 S.	29 E.	Wright-Bloemer 1	Mountain View
Mohawk Petroleum Co.	24	30 S.	28 E.	Eisen Vineyards 1	Mountain View
Mohawk Petroleum Co.	24	30 S.	28 E.	Mabry 1	Mountain View
Mohawk Petroleum Co.	24	30 S.	28 E.	McKeehan 2	Mountain View
Mohawk Petroleum Co.	30	30 S.	29 E.	Hood 4	Mountain View
Mountain View Oil Corp.	25	30 S.	28 E.	Garner-Bristol 1	Mountain View
Petro-Well Production Co., Ltd.	19	30 S.	29 E.	Petro-Well 1	Mountain View
Shell Oil Co.	30	30 S.	29 E.	Cowan 1	Mountain View
Sovereign Oil Corp.	30	30 S.	29 E.	San Joaquin 2	Mountain View
Standard Oil Co.	24	30 S.	28 E.	Ranton 1	Mountain View

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
KERN COUNTY—Continued:					
Union Oil Co.	23	30 S.	28 E.	Wible 1	Mountain View
Wood-Callahan Oil Co., Ltd.	30	30 S.	29 E.	National Oil 1	Mountain View
Rex Oil Co.	6	28 S.	29 E.	Rex 2	RoundMountain
A. T. Jergins Syn., Inc.	22	30 S.	29 E.	Hay 1	----------
Monterey Exploration Co.	22	30 S.	29 E.	Nozu 1	----------
The Ohio Oil Co.	20	27 S.	27 E.	Van Houten 1	----------
Union Oil Co.	15	30 S.	28 E.	Kernco 2	----------
KINGS COUNTY:					
Kettleman North Dome Assoc.	1	22 S.	17 E.	43	Kettleman North Dome
Kettleman North Dome Assoc.	16	22 S.	18 E.	55	Kettleman North Dome
Kettleman North Dome Assoc.	2	23 S.	18 E.	73	Kettleman North Dome
Standard Oil Co.	3	22 S.	17 E.	25	Kettleman North Dome
Standard Oil Co.	1	23 S.	18 E.	54	Kettleman North Dome
Commonwealth Consolidated Gas, Ltd.	21	22 S.	20 E.	2	----------
Trico Oil and Gas Co.	33	24 S.	22 E.	1	----------
LOS ANGELES COUNTY:					
Severins Drilling Co., Ltd.	24	3 S.	11 W.	3	Coyote Hills
Standard Oil Co.	13	3 S.	11 W.	Emery 57	Coyote Hills
Standard Oil Co.	13	3 S.	11 W.	Murphy-Coyote 119	Coyote Hills
Shell Oil Co.	33	3 S.	13 W.	Reyes 55	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 56	Dominguez
Shell Oil Co.	34	3 S.	13 W.	Reyes 57	Dominguez
Pacific Western Oil Co.	8	2 S.	14 W.	Rubel 17	Inglewood
Plymouth Oil Co.	7	2 S.	14 W.	Pollard 1	Inglewood
Shell Oil Co.	8	2 S.	14 W.	Rindge 16	Inglewood
Standard Oil Co.	7	2. S.	14 W.	Vickers 1 27	Inglewood
Standard Oil Co.	8	2 S.	14 W.	L. A. Investment Lease 70	Inglewood
Standard Oil Co.	17	2 S.	14 W.	Baldwin-Cienega 105	Inglewood
Apex Petroleum Corp., Ltd.	19	4 S.	12 W.	Apex Stratton 1	Long Beach
Apex Peteoleum Corp., Ltd.	19	4 S.	12 W.	Seegar 1	Long Beach
P. G. Cumming	20	4. S	12 W.	Shaver 8	Long Beach
Dabney-Johnston Oil Corp.	30	4 S.	12 W.	91	Long Beach
Deco Oil Co.	19	4 S.	12 W.	Deco 1	Long Beach
Italo Petroleum Corp.	29	4 S.	12 W.	Fee 1	Long Beach
Olmstead Petroleum Corp.	30	4 S.	12 W.	McKenzie 1	Long Beach
Rotary Drillers, Inc.	29	4 S.	12 W.	Hinshaw 1	Long Beach
Shell Oil Co.	29	4 S.	12 W.	Horsch 1-A	Long Beach
Shell Oil Co.	29	4 S.	12 W.	Kent-Garth 6	Long Beach
Southern Empire Petroleum, Inc.	30	4 S.	12 W.	Empire 2	Long Beach
The Texas Co.	30	4 S.	12 W.	Robinson 5	Long Beach
Union Oil Co.	30	4 S.	12 W.	Long Beach Comm. 23	Long Beach
Fullerton Oil Co.	6	2 S.	11 W.	McGinley F 28	Montebello
Fullerton Oil Co.	6	2 S.	11 W.	McGinley F 29	Montebello
Standard Oil Co.	6	2 S.	11 W.	Baldwin 74	Montebello
Standard Oil Co.	6	2 S.	11 W.	Baldwin 75	Montebello
Standard Oil Co.	6	2 S.	11 W.	Baldwin 76	Montebello
B. & L. Drilling Co.	14	3 N.	16 W.	B. & L. 1	Newhall
Union Oil Co.	28	2. S	15 W.	Del Rey 6	Playa del Rey
Woodward Oil Co., Ltd.	12	3 S.	14 W.	Scher 81	Rosecrans
Union Oil Co.	6	3 S.	11 W.	Bell 61	Santa Fe Springs
Union Oil Co.	6	3 S.	11 W.	Bell 64	Santa Fe Springs
Union Oil Co.	6	3 S.	11 W.	Bell 65	Santa Fe Springs
Union Oil Co.	6	3 S.	11 W.	Bell 66	Santa Fe Springs
International Oil Developers, Inc., Ltd.	34	5 N.	16 W.	Powell 301	----------
MADERA COUNTY:					
The Pure Oil Co.	7	10 S.	14 E.	Chowchilla 1	----------
MONO COUNTY:					
Fred Bauchwitz	19	3 N.	29 E.	Almedia 1	----------
ORANGE COUNTY:					
General Petroleum Corp.	6	3 S.	9 W.	Tonner 8-A	Brea-Olinda
Jim Bridger	15	3 S.	10 W.	Bridger 1	Coyote Hills
Standard Oil Co.	17	3 S.	10 W.	Murphy-Coyote 118	Coyote Hills
Union Oil Co.	22	3 S.	10 W.	Fullerton Heights 1	Coyote Hills
Avalon Oil Corp.	35	5 S.	11 W.	Plavan 1	Huntington Beach
Standard Oil Co.	3	6 S.	11 W.	Huntington B 69	Huntington Beach
Standard Oil Co.	4	6 S.	11 W.	P. E. 23	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	Huntington B 68	Huntington Beach
Standard Oil Co.	10	6 S.	11 W.	P. E. 22	Huntington Beach
E. J. Piatt and W. S. Collins	14	6 S.	10 W.	1	Newport
Speik Oil Co.	9	6 S.	10 W.	Derby 1	Newport

OIL FIELD DEVELOPMENT OPERATIONS—Continued

Company	Sec.	Twp.	Range	Well No.	Field
AN BENITO COUNTY:					
Cal-O-Tex Exploration Co.	8	17 W.	11 E.	1	
AN LUIS OBISPO COUNTY:					
Midway Peak Oil Co.	3	32 S.	22 E.	Midway Peak 1	
Panorama Oil Co.	2	32 S.	21 E.	Panorama 2	
ANTA BARBARA COUNTY:					
General Petroleum Corp.	32	5 N.	30 W.	Erburu 9	Capitan
Shell Oil Co.	32	5 N.	30 W.	Covarrubias 3	Capitan
Casmite Co.	13	9 N.	35 W.	Casmite 1	Casmalia
East Elwood Petroleum Corp.	14	4 N.	29 W.	Elwood 1	Elwood
Pacific Western Oil Co.	16	4 N.	29 W.	92 12	Elwood
Shell Oil Co.	20	4 N.	28 W.	Bishop 1	La Goleta
Standard Oil Co.	17	4 N.	28 W.	Chase & Bryce 2	La Goleta
Fred E. Cole	28	4 N.	27 W.	Perkins 1	Mesa
Fred E. Cole	28	4 N.	27 W.	Young 1	Mesa
East Elwood Petroleum Corp.	28	4 N.	27 W.	Low 1	Mesa
Daniel Fisher	28	4 N.	27 W.	Smith 1	Mesa
J. F. Garliepp, Trustee	28	4 N.	27 W.	Caldwell 1	Mesa
William Hughes	28	4 N.	27 W.	Hughes Patrick 1	Mesa
R. H. McIntosh	28	4 N.	27 W.	Beckstead 1	Mesa
Charles L. Ross	28	4 N.	27 W.	Ballantyne 1	Mesa
Stone Hastain	9	4 N.	28 W.	Simonds-Campbell 1	
Union Oil Co.	24	10 N.	34 W.	Moretti 1	
OLANO COUNTY:					
Cordelia Oil & Gas Co.	11	4 N.	3 W.	C. & H. Mangels 1	
ENTURA COUNTY:					
H. H. Humphreys	18	3 N.	19 W.	Humphreys 1	Bardsdale
The Texas Co.	4	3 N.	19 W.	Shiells 128	Bardsdale
Piru Oil Co.	14	4 N.	18 W.	Holser 1	Piru
Continental Oil Co.	23	3 N.	24 W.	Grubb 3	Rincon
American Drilling Co.	6	2 N.	17 W.	10-A	Simi
Chas. and Hoxie Anderson	36	3 N.	18 W.	Marr 13	Simi
Pomoc Oil Co.	5	2 N.	17 W.	1	Simi
Associated Oil Co.	27	3 N.	23 W.	Lloyd 135	Ventura
Associated Oil Co.	24	3 N.	23 W.	V. L. & W. 23	Ventura
Kittrell and Tucker	33	4 N.	23 W.	24	Ventura

SPECIAL ARTICLES

Detailed technical reports on special subjects, the result of research work or extended field investigations, will continue to be issued as separate bulletins by the Bureau, as has been the custom in the past.

Shorter and less elaborate technical papers and articles by members of the staff and others are published in each number of California Journal of Mines and Geology.

These special articles cover a wide range of subjects both of historical and current interest; descriptions of new processes, or metallurgical and industrial plants, new mineral occurrences, and interesting geological formations, as well as articles intended to supply practical and timely information on the problems of the prospector and miner, such as the text of the new laws and official regulations and notices affecting the mineral industry.

BIENNIAL REPORT OF THE STATE MINERALOGIST

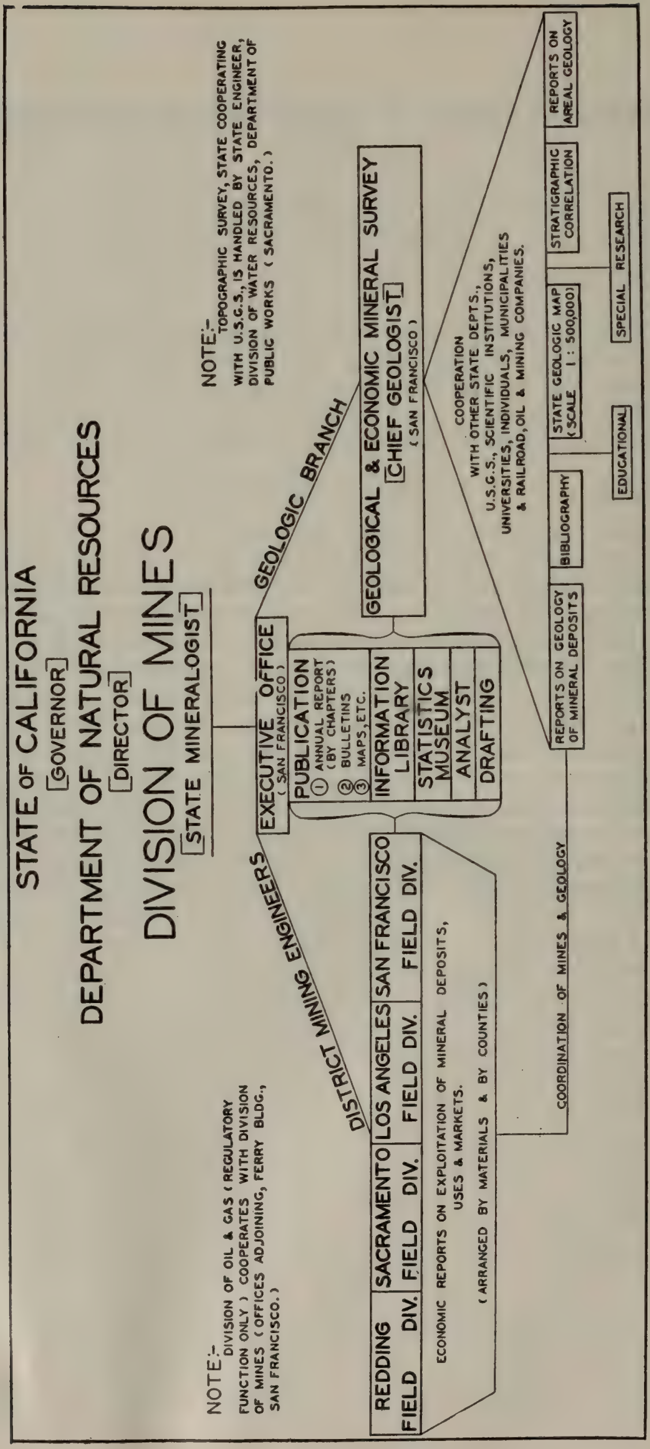
To HON. GEORGE D. NORDENHOLT, *Director,*
State Department of Natural Resources,
Sacramento, California.

SIR: Herein I have the honor to present the biennial report of the State Mineralogist as required by law (Stats. 1913, Chap. 679) for transmittal to His Excellency, Governor Frank F. Merriam, covering the work and activities of the Division of Mines of the Department of Natural Resources, for the period July 1, 1932, to June 30, 1934.

General Summary

The past two years (in fact, the past four) have been years of constantly increasing activity and interest in one branch especially of the mining industry and in which California leads our Nation—that of gold mining. As pointed out in our report of two years ago, this greater activity has enormously increased the demand upon the services and facilities of the Division of Mines, and for knowledge of the mineral resources of California, particularly in the gold districts. Unfortunately during the present biennium, the appropriation for the support of this division was cut nearly 30 per cent, in the face of the greater call for work to be done. This has made it necessary to curtail field work and even to completely stop it at periods. This, too, at a time when we are greatly embarrased many times daily for lack of up-to-the-minute information on current operations and developments. We have needed more than ever to make field trips and examinations. However, the confinement to the office desks has not been one of idle moments, by any means. Every member of the staff has been crowded with interviews, consultations and correspondence. We could have used additional personnel both in the offices and in the field. The Los Angeles district office has frequently reported upwards of 200 persons per day seeking data and information, the San Francisco office about the same, with the Redding and Sacramento offices 8 to 10. Sales of the publications of the division have been as high as $450 in a single month ($4,330 total for the past fiscal year). The laboratory has been swamped with mineral samples from all over the State, on which the senders desire information and advice. There were 12,000 samples received during the two-year period under review.

In consequence of the continuing large number of persons panning and washing for gold in the streams and gulches of our hills and mountains, and requiring avenues through which to dispose of their pannings, the number of ore-buyer's licenses issued by the State Mineralogist has steadily increased. For the calendar year 1932 there was a total of 108 such licenses issued; for 1933, there were 178; and in July, 1934, there were 220 in force. Of this last number, 122 were for


STATE OF CALIFORNIA
[GOVERNOR]
DEPARTMENT OF NATURAL RESOURCES
[DIRECTOR]
DIVISION OF MINES
[STATE MINERALOGIST]
NOTE:- DIVISION OF OIL & GAS (REGULATORY FUNCTION ONLY) COOPERATES WITH DIVISION OF MINES (OFFICES ADJOINING, FERRY BLDG., SAN FRANCISCO.)
NOTE:- TOPOGRAPHIC SURVEY, STATE COOPERATING WITH U.S.G.S., IS HANDLED BY STATE ENGINEER, DIVISION OF WATER RESOURCES, DEPARTMENT OF PUBLIC WORKS (SACRAMENTO.)
DISTRICT MINING ENGINEERS
GEOLOGIC BRANCH
EXECUTIVE OFFICE (SAN FRANCISCO)
PUBLICATION
① ANNUAL REPORT (BY CHAPTERS)
② BULLETINS
③ MAPS, ETC.
INFORMATION
LIBRARY
STATISTICS
MUSEUM
ANALYST
DRAFTING
REDDING FIELD DIV.
SACRAMENTO FIELD DIV.
LOS ANGELES FIELD DIV.
SAN FRANCISCO FIELD DIV.
ECONOMIC REPORTS ON EXPLOITATION OF MINERAL DEPOSITS, USES & MARKETS.
(ARRANGED BY MATERIALS & BY COUNTIES)
COORDINATION OF MINES & GEOLOGY
GEOLOGICAL & ECONOMIC MINERAL SURVEY
[CHIEF GEOLOGIST]
(SAN FRANCISCO)
COOPERATION WITH OTHER STATE DEPTS., U.S.G.S., SCIENTIFIC INSTITUTIONS, UNIVERSITIES, INDIVIDUALS, MUNICIPALITIES & RAILROAD, OIL & MINING COMPANIES.
REPORTS ON GEOLOGY OF MINERAL DEPOSITS
BIBLIOGRAPHY
STATE GEOLOGIC MAP (SCALE 1 : 500,000)
STRATIGRAPHIC CORRELATION
REPORTS ON AREAL GEOLOGY
EDUCATIONAL
SPECIAL RESEARCH

censes permitting aggregate purchases up to $1,000 for the year (fee 2), and 108 for the 'unlimited' license (fee $15). This does not egregate the 10 branches of the Bank of America buying under a ingle license issued to the parent corporation. The United States int does not accept less than two ounces of gold in a single deposit, o that practically all of these small placer operators with their few rains a day would be unable to dispose of their meager washings xcept for our licensed gold buyers situated in their local communities lose to the 'diggings.' Many of these are general merchandise stores, here the transaction is essentially that of exchanging food and clothng over the counter for the gold grains.

As a striking illustration of the interest and demand for informaion on gold placer-mining methods and areas, mention was made in ur last biennial report of our experience with the April, 1932, quarerly chapter of the State Mineralogist's Report because of matter ontained therein on this subject. The edition of 3000 copies (normally ve print 2000) was entirely gone in three weeks from the time it was eceived from the State Printer. A second edition of another 3000 opies lasted only a few months, but pending its printing, 2500 copies f a mimeographed synopsis was quickly distributed, and subsequently everal further editions of the synopsis were dispensed. All told somehing like 15,000 copies of this report and its synopsis have been sold uring the past two years. There is still a demand for it, so that we ave recently (April-July, 1934, quarterly) issued another edition, evised and enlarged, containing also descriptions of milling practices nd processes for treating gold ores. Though this latest bulletin has een off the press only a few weeks we have had many orders for it ven from points outside of California.

This present summer and fall we are having the services, through the State Emergency Relief Administration ('SERA') assignment, of three typists and two men assistants in the library and museum, indexing and cataloguing the publications of the division and rearranging the library files, particularly of the exchange reports and bulletins of the geological surveys of other States and foreign countries. We have a very valuable collection here of these reports, but it has accumulated in such a way that with our limited regular staff we have been unable to take the time in these days of strenuous mining activity to put these library files in order. This is now being accomplished and the files will be readily accessible and thereby more useful, as they contain much valuable data for which there is daily demand from engineers, scientists, students, prospective investors and others. In the mineral exhibit, new cards are being typed, the specimens dusted off and in part rearranged.

On the subject of expenses, in 1933 we adopted the use of 1-cent postal cards for replies to correspondents wherever possible—particularly to a considerable number of inquiries relating to publications of this division as to prices and mailing charges. This use of postal cards not only cuts postage, but also the items of stationery for letter-heads and envelopes and the stenographers' time. We also ask those on certain of our "exchange" and free mailing-lists to pay the postage or expressage on publications being sent. This has reduced our shipping costs materially.

In our January-April, 1933, issue of the quarterly chapters of the State Mineralogist's Report, we published a paper on ''Lakes of California,'' by William Morris Davis, professor emeritus of geology of Harvard University and a nationally recognized authority on physiographic geology, he being at the time a member of the faculty of the California Institute of Technology at Pasadena. We had so many requests for copies of this ''Lakes of California'' by teachers in high schools and junior colleges for use in their classes in physiography that we had a reprint of 1000 copies made so that it is now available for sale separately from the balance of the original publication. The manuscript of this article was donated to the State Division of Mines by Dr. Davis (since deceased) without cost to the division except a small expense incident to a couple of field trips to complete observations and data in certain portions of the State.

Referring again to the subject of gold mining: Everyone is now more or less familiar with the several advances in 1933 in the price of the yellow metal above the time-honored $20.67 per fine ounce, culminating with President Roosevelt's fixing it at $35 on January 31, 1934. After each proclamation by the President, new rules and regulations were promulgated by the United States Treasury Department dealing with the purchase or sale of gold bullion, amalgam, concentrates, or other such products. The State Division of Mines has kept in close touch with the San Francisco mint and the treasury officials in order to advise mine operators and our licensed ore and bullion buyers in California, and mimeographed instructions have been distributed for their information.

In both 1933 and 1934, Congress passed bills waiving the requirement for the annual assessment work on mining claims. The State Mineralogist kept mine owners advised as to the requirements and procedure through means of press bulletins, in which was included a suggested form for filing one's ''desire to hold'' claims under benefit of these acts. In 1934, there was also enacted an amendment introduced by Representative Englebright of California to the famous Caminetti Act dealing with hydraulic mining in this State, which will simplify the procedure and reduce the cost to the mine owners in the provision for financing debris dams. This, coupled with the formation of placer mining districts under the provisions of the Seawell bill passed by our 1933 Legislature, should result in a revivification of the Sierran foothill country from Amador County to Plumas County and the production of many millions of new gold.

Each of the past two years, the Division of Mines has placed an exhibit of California's mineral resources at the State Fair. Owing to lack of funds, this would not have been possible except for the generous assistance of friends and mine operators. Among these special mention is due the Mining Committee of the Sacramento Chamber of Commerce, and the Remington Rand Company, who supplied us with an electric-lighted safe for the display of gold specimens loaned by a number of mining companies. Similarly, in September of this year, at the convention of the American Mining Congress at the Palace Hotel, San Francisco, we were enabled to place an exhibit of charts and maps depicting California's mineral industries, through the courtesy of the California Wire Cloth Company's paying for the space and donating it to our use.

During the calendar year 1932, there was reported commercial production of fifty different mineral substances having a total value in the crude state of $199,196,493, being a decrease of $16,767,927 from the total of $215,964,420 for 1931, due principally to declines in values registered by miscellaneous stone (crushed rock, sand, gravel), cement, borates, brick and building tile, soda and natural gas. Petroleum and gold each increased approximately a million dollars. In 1933 there was an increase in value of $7,290,065 to a total of $206,486,558 and fifty-five different substances listed. Practically all of the more important mineral substances showed an increased value, led by gold, cement, petroleum, salt, soda, potash, borates, diatomite, lime, barytes, pottery clay, dolomite, silica, silver.

Geologic Branch

The progress being made under our geological survey program continues highly gratifying, even to the point of embarrassment, because of the insufficiency of funds for printing reports and maps already available for publication. The following is a progress statement prepared by Dr. Olaf P. Jenkins, Chief Geologist, under date of August 1, 1934:

"One of the chief functions of the California State Division of Mines of the State Department of Natural Resources is that of collecting and making available geological information, because geology is the very foundation of mining, and mineral exploration is geology. For the past five years the Division of Mines has maintained an active geological survey. Through its efforts a remarkable amount of valuable information has been accumulated. Not only has this information been secured and assembled, but it has been coordinated in such a manner as to form a systematic framework of intelligible knowledge for engineers and others to use in their analyses of problems in mining and in various other industries. The Geologic Branch acts as a clearing house for this information. The service which the Division of Mines constantly maintains in giving reliable and useful information concerning the mineral resources of the State is thus greatly augmented. The offices of the division are therefore eagerly and continually sought after for all kinds of geological knowledge. Also other engineering divisions of the State are now learning that the Division of Mines has much that can help them in the solution of their problems.

"One of the most remarkable features of this geological survey, is the way it has gone about getting such a lot of work done on so very little money. This has largely been due to the concerted efforts of the State Mineralogist together with his Chief Geologist in securing cooperation from many different appreciative sources: mining and oil companies, members of geological departments in various institutions of learning, Federal departments, and from many individuals who see the value in the undertaking.

"The United States Geological Survey is actively cooperating with the Division of Mines in preparing a large up-to-date colored geological map of California. Preliminary sheets of parts of this map have already been issued. The Sierra Nevada portion of this map has already undergone a second reprint, several thousand copies having been distributed. A complete bibliography of all publications on the geology and mineral resources of the State has been issued, which gives a comprehensive indexed catalogue of all available published information. Various geologic reports of specific areas have been prepared covering regions scattered over the State from the northern boundary to San Diego County, and from the Pacific Ocean to the easternmost counties. The geology described covers all kinds of country. including mining districts and areas of special interest to the oil industry. Some reports have been written on some special topic, such as building stone, clay and sand, or on some more fundamental or educational subject, as the lakes of California, which has received much popularity and many favorable comments.

''The ultimate goal has been to bring together in a sensible manner the various researches in geology for the purpose of coordinating them so that practical application may be made of all this knowledge. To do this, takes a geologist of considerable breadth of knowledge, experience and vision, as well as ability to organize and carry out explorations.

''For the past year practically no money has been available through the Division of Mines to carry on this work, with the exception of the salary of the Chief Geologist. But even with the handicap of the lack of money, a lot of fine work is actually being done, and new and interesting discoveries are being made. Various persons have been much interested in making this geological work a success and we owe much to their hard work and unselfish free contributions.

''In a number of cases research geologists, through funds of their own or small research grants, have been able to work out certain geological problems in view of using the material gathered for a doctor's thesis in some University. These geologists have found it advantageous to confer with the Chief Geologist of the Division of Mines so as to assure the coordination of their problems with other important work being carried on elsewhere. The final result has in several cases been the preparation of a fine report published in the division's quarterly publication designated as the 'California Journal of Mines and Geology.' In the past, the division has been able to give a small amount of financial assistance to some of the work, getting in return, it is estimated, reports which would have cost six to ten times the amount had the State employed men for the work. But even without this expense allotment during this past year, the work has kept a steady pace ahead. Federal aid has given some clerical, stenographic assistance and supplied cartographers in the preparation of the splendid State geological map now undergoing a careful revision. This work is all being done under the direct personal supervision of the Chief Geologist. Much information is being received from various sources which is being very kindly contributed to make this important project a success.

''Working in the field, but without expense to the State, though their work is considered part of our geologic program, are the following:

''1. Dr. Evans B. Mayo—on the geology along the eastern front of the Sierra Nevada, especially in southeastern Mono County.

''2. Mr. Francis Frederick—on the geology and ore deposits of the Bodie mining district, Mono County.

''3. Dr. C. D. Hulin—on the geology of the Searles Lake quadrangle, San Bernardino, Inyo and Kern counties.

''4. Mr. Cardell Durrell—on the geology of the Kaweah quadrangle, Tulare County.

''5. Mr. G. F. Seager—on the geology of the Shasta County copper district.

''6. Dr. J. S. Hollister—on the geologic structure of the Coast ranges.

''7. Mr. John C. Hazzard—on the geology and mineral deposits of parts of San Bernardino County.

''8. Dr. E. Wayne Galliher—on the sand deposits of California.

''9. William Q. Wright and Burt Beverly (under the direction of Olaf P. Jenkins)—on the methods of exploration by geological and geophysical methods of the buried gold-bearing river channels of California.

''These men are qualified by their identification with professional practice and with such universities as California, Cornell, Yale, Stanford, California Institute of Technology and the University of Southern California. Besides these men who are in the field at present, there are a number of others whose reports are in preparation. Some of these reports are now undergoing editing and are ready for the printer when publication funds are available, as, for example:

''1. Geology and mineral resources of the Elizabeth Lake quadrangle in Los Angeles and Kern counties, by E. C. Simpson.

''2. Geology and ore deposits of the Julian district, San Diego County, by Maurice Donnelly.

''3. Clays of Riverside and Orange counties, by J. Clark Sutherland.

''4. Underground geology of the Grass Valley district, by W. D. Johnson.

''5. Graphite deposits of Los Angeles county, by Burt Beverly.

''6. Geology and mineral deposits of parts of Marin and Sonoma counties, by F. A. Johnson.

''7. Geology and mineral deposits of the Lucia quadrangle, Monterey County, by Parry Reiche.

''The results of the investigations by these geologists and several others not herein mentioned, will eventually be made available through publication by the State Division of Mines. This organization, therefore, gets the benefit of the work of about a score of geologists, whose total expenses and salaries if paid by the State would have been for the biennium, it is conservatively estimated, over $50,000, which is more than five times the Chief Geologist's salary during this two-year period. In addition to this estimated amount, an actual contribution of $5,000 was made through the office of the United States Geological Survey for geological draftsmen on the State geologic map, which is being done under the direct supervision of the Chief Geologist. Through Federal emergency funds for the unemployed, secretarial aid has been given the Chief Geologist, whose assistants would normally have cost the State over $3,000. Not only has all this work and cooperation been secured through his efforts, but he supervises the field work, edits the final reports, and carries on practical geological research, besides. Since State traveling funds have been lacking this past year, and since geological advice has been sought after by a number of mining concerns, several of these companies have contributed field expenses to enable him to carry on several important field investigations above noted. This has amounted to a few hundred dollars.

"It may be readily seen, therefore, that the practical application of the work of the geological survey has taken a strong foothold in California, though the State has contributed comparatively very little money for its maintenance. It is a service of great moment especially during this time of exploration for new gold deposits.

"Practically all the other States of the Union now have a geological survey as a distinct departmental organization. Here in California, the Division of Mines, through its district mining engineers, its librarian, statistician, analyst, clerks, etc., carries on much of the work which other State surveys do, in addition to their geological mapping programs. It was only after a period of over half a century that a geological survey was finally established as part of the Division of Mines. Its program of endeavor, its execution of work, its economy in carrying on this work, and the cooperation it has secured from a large number of sources has been extremely gratifying. It constitutes one of the most fundamental and therefore practical parts of the organization. The maintenance of the Geological Branch as an important part of the Division of Mines is, therefore, highly essential to the exploration and development of California's vast store of valuable mineral resources."

Publications

Publications issued July 1, 1932 to June 30, 1934:

July and October chapters (combined) of State Mineralogist's Report XXVIII, 1932. Among the more important subjects included were:

Mineral resources of Ventura County; Report Accompanying Geologic Map of Sierra Nevada; Notes on Occurrence and Age of Fossil Plants found in the Auriferous Gravels of Sierra Nevada; Glacial and Associated Stream Deposits of the Sierra Nevada; Jurassic and Cretaceous Divisions of the Knoxville-Shasta Succession of California; Geology of a Part of the Panamint Range, Inyo County; Mineral Resources of a Part of the Panamint Range.

Special articles on: Acquiring Mining Claims through Tax Title; Biennial Report of the State Mineralogist.

State Mineralogist's Report XXIX, 1933, which contained the following more important articles:

Gold Deposits of the Redding and Weaverville Quadrangles; Geologic Formations of the Redding-Weaverville Districts (with map); Economic Geology of Portions of Del Norte and Siskiyou Counties; Applications of Geology to Civil Engineering; The Lakes of California; Gold Resources of Kern County.

Special articles on: Discovery of Piedmontite in the Sierra Nevada; Suspension of Assessment Work; Tracing Buried River Channel Deposits by Geomagnetic methods; Limestone Deposits of the San Francisco Region; Limestone Weathering and Plant Associations of the San Francisco Region; Booming; Death Valley National Monument; New State Legislation.

January, also April and July (combined) chapters of the State Mineralogist's Report XXX, 1934, containing special articles on:

Resurrection of Early Surfaces in the Sierra Nevada; Geology and Mineral Resources of Northeastern Madera County; Geology and Mineral Deposits of Laurel and Convict Basins, Southwestern Mono County; Notes on Sampling Applied to Gold Quartz Deposits; Elementary Placer Mining in California and Notes on the Milling of Gold Ores (containing descriptions of over 200 special machines and processes).

Bulletin 107. California Mineral Production and Directory of Mineral Producers for 1931, by Henry H. Symons, 229 pages, 10 illustrations. Gives detailed figures of commercial production of all mineral substances in California for the calendar year 1931.

Bulletin 109. California Mineral Production and Directory of Mineral Producers for 1932, by Henry H. Symons, 200 pages, 10 illustrations.

NOTE.—Bulletin 108, "Mother Lode Gold Belt," by C. A. Logan, is in press and should be available for distribution before the end of the current calendar year.

Conclusion

Because of the increased demands upon the services and facilities of the Division of Mines, previously described in this report, we can well justify an increase in the appropriation request for the coming biennium. The outstanding need both in our economic developmental functions and in the geologic branch is financial support for keeping up to date in the field work and a more liberal allowance for printing the results of field studies, some of which have already been made and others which should be made. It should be borne in mind that the money spent in printing these reports of the Division of Mines comes back to the State treasury, as the books are sold at a price which approximates the cost of printing.

We would reiterate what we have said in previous reports that it can not be too strongly emphasized that the functions of the Division of Mines are developmental and bring capital into California, building up industries and pay rolls and providing active taxable properties. Not only that, but in these recent times of distress this division has been particularly indispensable and helpful to the many thousands of unemployed who are seeking (and finding in a greater or less measure) a living in the placer gold districts.

Respectfully submitted.

WALTER W. BRADLEY,
State Mineralogist.

San Francisco, October 1, 1934.

GOVERNMENT CAN NOT CHALLENGE RIGHT TO MINING CLAIMS FOR FAILURE TO PERFORM ANNUAL ASSESSMENT WORK WITHIN WITHDRAWN AREAS.

It is quite commonly believed that the locator of an unpatented mining claim loses the title to his claim if he fails to do the required annual assessment work. This is not true. Failure to do the assessment work for any year merely throws the claim open to location (jumping) by another, but so long as no relocation of the claim is made by another, the title rests with the original locator. He can resume work at any time and his title will be as good as if he had done the work. In other words, the locator of a valid claim may leave the claim for years without doing any assessment work and if it has not been relocated by another during the intervening time, he may return, do the current year's work and record it, and his title will be maintained.

The Department of the Interior had held in several cases that this rule was abrogated by the Leasing Act and that failure to do the annual labor operated as a forfeiture of the location when within such withdrawn area, with the land reverting to the public domain without right of relocation. This point was definitely settled by the Supreme Court of the United States in the case of *Krushnic* vs. *West, Secretary of the Interior,*[1] contrary to the contention of the Land Department An even stronger case, *Ickes, Secretary of the Interior,* vs. *Virginia-Colorado Development Corporation,* has recently been decided by the Court of Appeals of the District of Columbia, which is summarized herein.

ICKES, Secretary of the Interior, vs. VIRGINIA-COLORADO DEVELOPMENT CORPORATION. No. 5956

Court of Appeals of the District of Columbia.

Argued Nov. 6, 1933.

Decided Jan. 22, 1934.

Syllabus

1. Mines and minerals.

Failure of holder of oil shale placer claims to perform annual assessment labor *held* not to entitle government to declare forfeiture of claims, in absence of relocation of claims or application to lease such lands (30 USCA §§ 28, 29; Leasing Act Feb. 25, 1920, 41 Stat. 437)

2. Injunction.

Mandatory injunction against Secretary of Interior restraining any action interfering with title to oil shale placer claims sought to be forfeited without authority held proper (30 USCA §§ 28, 29).

Appeal from the Supreme Court of the District of Columbia.

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[1] Mining in California, July, 1929, quarterly Chapter of State Mineralogist's Report XXV, pp. 378–386.

Suit by the Virginia-Colorado Development Corporation against Harold L. Ickes, as Secretary of the Interior. From a decree in favor of the plaintiff granting a mandatory injunction, the defendant appeals.

Decree affirmed.

Nathan R. Margold, Charles Fahy, and Victor H. Wallace, all of Washington, D. C., for appellant.

Louis Titus and Charles L. Frailey, both of Washington, D. C., for appellee.

Before MARTIN, Chief Justice, and ROBB, HITZ, and GRONER, Associate Justices.

MARTIN, Chief Justice.

This is an appeal to the Secretary of the Interior from a decree of mandatory injunction requiring him to vacate a decision promulgated by him whereby certain oil shale placer claims of the appellee were declared to be null and void.

The appellee, the Virginia-Colorado Development Corporation, as plaintiff below and hereinafter called the plaintiff, filed its bill below praying for an injunction against the appellant upon allegations in substance as follows:

That in June, 1917, the plaintiff, under the mining laws then in force, located certain oil shale placer claims in Colorado known as the Mt. Mamm, Nos. 12 to 17. It was required by the statutes (Rev. St. §§ 2324, 2325, 30 USCA §§ 28, 29) that until a patent was issued for the claims, "not less than $100 worth of labor shall be performed or improvements made during each year; * * * and upon a failure to comply with these conditions, the claim or mine upon which such failure occurred shall be open to relocation in the same manner as if no location of the same had ever been made, provided that the original locators, their heirs, assigns, or legal representatives, have not resumed work upon the claim after failure and before such location."

That plaintiff from the time of the location of the claims in 1917, up to and including the year ending July 31, 1930, performed the assessment work of not less than $100 annually as required by the statute, but failed to perform such labor during the year ending July 31, 1931. That this default continued throughout the months of July, August, and part of September, 1931; but plaintiff intended on and prior to September 4, 1931, to resume work upon the claims, and had made arrangements to do so, and would have done so, had it not been prevented from performing such labor by the action of the Secretary of the Interior complained of in this case. That the plaintiff never at any time abandoned nor had any intention of abandoning the claims.

That on September 4, 1931, certain adverse proceedings were initiated by the Department of the Interior, through the General Land Office, against plaintiff's claims by the filing in the Land Office and posting on the claims of a challenge to the plaintiff's right and title thereto. This challenge was based solely upon the ground that plaintiff had failed to perform the assessment labor for the year ending July 31, 1931, and had not resumed such labor before the challenge was filed and posted. The challenge stated that the United States had therefore resumed possession of the land within the claims. It was not charged that the plaintiff's right or title to the claims was otherwise invalid, or ever had been so, or that plaintiff had abandoned the claims. It was based upon the sole ground that plaintiff's failure to perform assessment work for the year ending July 31, 1931, and before the filing of the challenge on September 4, 1931, had entitled the Secretary to declare a forfeiture of plaintiff's right and title to the claims and made them subject to cancellation by the government. No relocation of the claims had been made or attempted by any other person or company during this period, nor had anyone made application to lease the lands from the government.

That plaintiff contested the proceedings in the General Land Office, but the Commissioner held that plaintiff's claims were null and void, and upon appeal this decision was affirmed by the Secretary of the Interior. That on July 15, 1932, the Department's decision was promulgated declaring the plaintiff's claims to be null and void, and asserting that the United States had taken possession of the lands within the claims for its own uses and purposes. The plaintiff seasonably objected to all of these proceedings.

Thereupon plaintiff filed its bill in equity in the Supreme Court of the District of Columbia in the present case praying for a mandatory injunction requiring the Secretary of the Interior to vacate his decision declaring the plaintiff's claims null and void. The court below granted the decree prayed for, and enjoined the Secretary from taking any action interfering with plaintiff's title to the claims. The Secretary then appealed from this decision.

[**1**] The question involved in this case is whether the failure of plaintiff to perform the annual assessment labor upon the claims in the year ending July 31, 1931, entitled the government to declare a forfeiture of the claims and take possession thereof to the exclusion of all rights of the plaintiff. It is conceded by appellant that no such forfeiture was provided for under the Mining Law of May 10, 1872, Rev. St. §§ 2324, 2325, supra, under which plaintiff had located the claims, but it is contended that under the Leasing Act of February 25, 1920, 41 Stat. 437, such a right was vested in the government, and the annual performance of labor on such locations was necessary to preserve the possessory right of the locator as against the government.

We do not agree with this contention.

The Secretary's proceedings might be sustained if the present claims were governed by the provisions of the Leasing Act, but section 37 of that act (30 USCA § 193) contains a saving clause excepting from its provisions all ''valid claims existent at date of the passage of this act [February 25, 1920], and thereafter maintained in compliance with the laws under which initiated, which claims may be perfected under such laws, including discovery.''

It is contended by appellant that the claims now in question, although initiated under the mining laws, were not maintained in compliance therewith; and therefore were not excepted by the proviso from the operation of the Leasing Act. This contention is based upon the failure of the plaintiff to perform the annual labor for the year ending July 31, 1931. Appellant alleges that the plaintiff, consequently, is not entitled to the benefit of the saving clause aforesaid. We can not gree with this position for the reason, as held by the Supreme Court f the United States with respect to such claims, in Wilbur v. U. S. ex el. Krushnic, 280 U. S. 306, 314, 50 S. Ct. 103, 104, 74 L. Ed. 445, ffirming United States ex rel. Krushnic v. West, Secretary of the nterior, 58 App. D. C. 332, 30 F.(2d) 742, that "prior to the passage f the Leasing Act, annual performance of labor was not necessary to reserve the possessory right, with all the incidents of ownership above tated, as against the United States, but only as against subsequent elocators. So far as the government was concerned, failure to do ssessment work for any year was without effect." It follows that nasmuch as the government, prior to the passage of the Leasing Act, vas without authority to declare a forfeiture of these claims because f the failure of plaintiff to perform the required annual assessment vork, and inasmuch as the claims in question were saved out of the peration of the Leasing Act by the proviso above quoted, the action of he Secretary in his challenge of the plaintiff's claims and his resumption thereof for the United States were without authority of law and vere null and void.

[**2**] It is claimed by appellant that it was error for the lower court to ssue a writ of mandatory injunction against the Secretary of the Interior in this case. We are of the opinion that this contention is foreclosed by the decision of the Supreme Court of the United States in Wilbur v. Krushnic, supra. In that case it was held that the lower court possessed authority to issue a writ of mandamus against the Secretary based upon facts similar in principle to those involved in the present case. In view of that conclusion it follows that it was not error for the court in this case to issue a mandatory injunction to afford similar relief based upon similar facts.

The decree of the lower court is therefore affirmed.

DEATH VALLEY NATIONAL MONUMENT IS NOW OPEN T MINING

When Death Valley National Monument, comprising an area o approximately 1,601,800 acres, was established on February 11, 1933, all land therein not held under valid existing rights was withdraw from entry, and warning given all persons "not to locate or settle upo any of the lands thereof."

The restriction thus imposed on mining in this region was remove later by passage of the act of June 13, 1933 (48 Stat. 139) extendin the mining laws of the United States to the Death Valley Nationa Monument; and the regulations under said act issued by the Depart ment of the Interior are given in a letter to the Register of the U. S General Land Office at Sacramento, copy of which follows:

UNITED STATES

DEPARTMENT OF THE INTERIOR

General Land Office

Washington

June 7, 1934.
: Regulations.

Register, Sacramento, California.

SIR: The act of June 13, 1933, Public No. 49, (48 Stat. 139) a act to extend the mining laws of the United States to the Death Valle National Monument in California, provides as follows:

> Be it enacted by the Senate and House of Representatives of th United States of America in Congress assembled, That the mining laws o the United States be, and they are hereby, extended to the area include within the Death Valley National Monument in California, or as it ma hereafter be extended, subject, however, to the surface use of locations entries, or patents under general regulations to be prescribed by the Secretary of the Interior.

Under this act, the lands reserved by the proclamation of Februar 11, 1933, as the Death Valley National Monument, are open to prospecting, location, entry and patent under the United States mining laws subject to the conditions as to surface use of claims located, entered o patented prescribed under general regulations by the Secretary of th Interior. It is not the intention of the Department of the Interior t hamper in any way legitimate prospecting or mining activities; on th contrary, it is the desire of the Department to foster such activities, and it is believed that the development of the monument by roads, trails and in other ways will be of great assistance to prospectors and miners

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[1] See State Mineralogist's Report XXIX, pp. 371–372, 1933.

Accordingly, the following regulations are prescribed to govern ie surface use of such claims:

> 1. The claim shall be occupied and used exclusively for mineral exploration and development and for no other purpose; except that, upon written permission of the Director of the National Park Service, the surface of the claim may be used for other specified purposes, the use to be on such conditions and for such period as may be prescribed when permission is granted.
>
> 2. The owner of the claim and all persons holding under him shall conform to all rules now prescribed or which may be made applicable by the Director of the National Park Service, governing occupancy of lands within the national monument.
>
> 3. Use and occupancy of the surface of mining claims as herein prescribed shall apply to all such claims located after the date of the act within the limits of the national monument as fixed by said proclamation of February 11, 1933, and to all mining claims on lands hereafter included in the national monument, located after such inclusion, so long as such claims are within the boundaries of said monument.

Mineral applications for patents and final certificates issued hereon for lands in this monument should be noted "Death Valley ational Monument Lands" whether for lands located prior or subseuent to the act, and all patents issued for claims under the act will ontain appropriate reference to the act and these regulations.

Very respectfully,

ANTOINETTE FUNK,
Acting Commissioner.

concur: May 16, 1934.
(Sgd.) Arno B. Cammerer,
Director, National Park Service.

pproved: June 7, 1934.
(Sgd.) Harold L. Ickes,
Secretary.

ADMINISTRATIVE

WALTER W. BRADLEY, State Mineralogist

Personnel.

There have been no changes of personnel in the Division of Mines to be noted, during the past three months.

On August 8th, Governor Frank F. Merriam appointed the following as members of the State Mining Board: Charles G. Johnson, State Treasurer, Sacramento; Edward Morris Smith, Los Angeles; Robert A. Kinzie, San Francisco; Charles H. Segerstrom, Sonora; Errol MacBoyle, Grass Valley.

New Publications.

'California Journal of Mines and Geology' (quarterly) April and July, 1934, being Chapters 2 and 3 (combined) of the State Mineralogist's Report XXX; price 80 cents, plus 10 cents postage. Contains: 'Elementary Placer Mining in California and Notes on the Milling of Gold Ores,' including sections on 'Special Machines and Processes,' 'Black Sand Treatment,' 'Marketing of Products,' 'Prospecting for Vein Deposits,' 'Bibliography on Placer Mining.' Mineral Statistics.

Bulletin No. 109, 'California Mineral Production and Directory of Mineral Producers for 1932,' by Henry H. Symons, 200 pages, 10 illustrations; price 25 cents, plus 5 cents postage.

Commercial Mineral Notes, Nos. 135–138 (inclusive), July-October (inclusive), 1934, respectively. These 'notes' contain the lists of 'mineral deposits wanted,' and 'mineral deposits for sale,' issued in the form of a mimeographed sheet monthly. It is mailed free to those on the mailing list for 'California Journal of Mines and Geology.' As an evidence of the interest in mines and mineral resources now showing considerable activity, this mimeographed 'sheet' has had to be expanded to three pages in recent months.

Mails and File.

The Division of Mines maintains, in addition to its correspondence files and the library, a mine file which includes original reports on the various mines and mineral properties of all kinds in California.

During each quarterly period there are several thousand letters received and answered at the San Francisco office alone, covering almost every phase of prospecting, mining and developing mineral deposits, reduction problems, marketing of refined products and mining law. In addition to this, hundreds of oral questions are answered daily, both at the main office and the district offices, for the many inquirers who come in for personal interviews and to consult the files and library.

MINERALS AND STATISTICS

Statistics, Museum, Laboratory

HENRY H. SYMONS, Statistician and Curator

STATISTICS

Tabulations are presented herein showing the completed totals for all substances for the year 1933 grouped by substances and by counties. The complete, detailed annual report on the mineral production of California for 1933 will be available, as Bulletin No. 110 of the State Division of Mines.

Summary for 1933.

The total value of the mineral output of California for the year 1933 was $206,489,058, being an increase of $7,292,565 over the total of 1932, which was $199,196,493. There were fifty-five different mineral substances exclusive of a segregation of the various stones grouped under gems, and all the fifty-eight counties of the State contributed to the list.

As revealed by the data following, the salient features of 1933 compared with the previous year were: Practically all of the most important mineral substances showed an increased value, led by gold, cement, petroleum, salt, soda, potash, borates, diatomite, lime, barytes, pottery clay, dolomite, silica and silver. Those showing a decreased value were brick and hollow-building tile, natural gas, mineral water, copper, lead and quicksilver. Fluorspar, iodine, molybdenite and zinc were again included in the list of producers and wollastonite, a new material, was added to our commercial output.

Of the fuels, petroleum showed an increase in value of $173,725, although there was a decrease in amount from 177,745,286 barrels to 172,139,362 barrels of crude oil. The prices received on the lighter gravity oils were slightly higher than in 1932. Natural gas decreased from 284,168,872 M cu. ft. worth $16,272,061 to 271,743,544 M cu. ft. worth $15,403,514.

Of the metals, the gold yield showed an increase from 569,166.99 fine ounces to 613,578.85 fine ounces and in value from $11,765,726 to $15,683,075. The gold value for 1933 was calculated at an average weighted price of $25.56 a fine ounce. Zinc shipments were resumed during the year; silver value increased from $139,176 to $140,907, although the amount showed a decrease from 493,533 fine oz. to 402,591 fine oz. Chromite and tungsten ores also showed an increased output and value; copper, lead and quicksilver decreased in both amount and value from the previous year.

Of the structural materials cement increased from 5,657,549 bbls., worth $7,967,107 to 7,284,031 bbls. worth $10,331,395; magnesite also showed an increased value. Decreases were registered by brick and hollow-building tile from a total value of $1,605,086 to $1,520,481;

miscellaneous stone from a value of $7,183,643 to $6,871,581 and granite from $398,676 to $183,706. Marble and sandstone also showed decreased values.

Of the industrial materials, increased values were registered by barytes, bentonite, pottery clay, dolomite, gypsum, slate, talc and soapstone, diatomite and pyrite, but not enough to offset the decline in mineral water. The total value of the group decreased from $3,822,598 to $3,687,195.

Of the salines all materials of the group showed an increased value with the exception of calcium chloride. The group as a whole showed an increased total value from $6,135,440 to $8,652,224.

By Substances

The distribution of the 1933 output of California by substances is shown in the following tabulation:

Substance	Amount	Value	Number of producers
Barytes	8,405 tons	$49,595	5
Bentonite	4,605 tons	60,621	8
Borates	197,495 tons	3,019,513	5
Brick and hollow building tile	-------	1,520,481	51
Cement	7,284,031 bbls.	10,331,395	10
Clay (pottery)	141,629 tons	211,711	51
Coal	2,612 tons	11,367	3
Copper	992,515 lbs.	63,521	5 [e]
Dolomite	54,456 tons	176,575	5
Gems	-------	690	3
Gold	613,579 fine oz.	15,683,075	[a]
Granite	-------	183,706	18
Gypsum	59,235 tons	120,451	6
Lead	772,463 lbs.	28,583	6 [e]
Lime	33,425 tons	271,619	8
Limestone	207,371 tons	487,712	19
Magnesium salts	2,073 tons	159,660	3
Marble (onyx and travertine)	-------	23,178	4
Mineral water	15,650,406 gals.	719,746	38
Natural gas	271,743,544 M cu. ft.	15,403,514	[b]
Petroleum	172,139,362 bbls.	143,063,972	[b]
Platinum	237 fine oz.	7,255	8 [e]
Pumice and volcanic ash	8,243 tons	61,087	11
Quicksilver	4,102 flasks	229,472	70
Salt	321,312 tons	1,251,024	9
Sandstone	-------	10,888	6
Silica (sand and quartz)	70,329 tons	266,520	9
Silver	402,507 fine oz.	140,907	[f]
Slate	5,343 tons	31,958	3
Soapstone and talc	14,451 tons	153,668	8
Soda	70,598 tons	1,019,130	4
Stone, miscellaneous	[c]	6,871,581	256
Tungsten	148 tons	76,605	3
Zinc	290,222 lbs.	12,189	2 [e]
Unapportioned	[d]	4,766,089	[d]
Total value		$206,489,058	

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[a] There were 797 lode mines and 993 placer mines, not including snipers, prospectors, and various individuals who sold small lots.

[b] There was an average of 9457 producing wells.

[c] Includes macadam, crushed rock, ballast, rubble, riprap, sand and gravel.

[d] Includes bituminous rock (2), bromine (1), calcium chloride (1), carbon dioxide (1), chromite (3), diatomite (7), fluorspar (1), feldspar (1), graphite (1), iodine (3), magnesite (2), mica (1), mineral paint (1), molybdenum (1), potash (1), pyrite (2), sillimanite-andalusite-cyanide group (2), sulphur (2), wollastonite (1), tube mill pebbles (1).

[e] Also included under gold.

[f] See copper, gold and lead as silver is a by-product of these metals.

By Counties

Distribution by counties is given in the following tabulation:

County	*Value*
Alameda	$1,930,111
Alpine	12,724
Amador	2,028,598
Butte	404,661
Calaveras	938,981
Colusa	8,896
Contra Costa	1,231,971
Del Norte	3,062
El Dorado	920,747
Fresno	3,901,103
Glenn	11,690
Humboldt	71,051
Imperial	166,858
Inyo	1,014,713
Kern	27,877,930
Kings	25,474,252
Lake	134,851
Lassen	45,739
Los Angeles	68,785,294
Madera	133,105
Marin	205,150
Mariposa	575,118
Mendocino	35,283
Merced	766,014
Modoc	166,747
Mono	81,147
Monterey	114,040
Napa	209,542
Nevada	4,767,391
Orange	19,263,581
Placer	293,866
Plumas	131,150
Riverside	2,218,738
Sacramento	3,172,763
San Benito	247,479
San Bernardino	8,975,485
San Diego	620,881
San Francisco	7,734
San Joaquin	153,127
San Luis Obispo	55,914
San Mateo	1,569,480
Santa Barbara	7,011,773
Santa Clara	534,378
Santa Cruz	1,234,180
Shasta	1,113,395
Sierra	449,146
Siskiyou	374,178
Solano	16,996
Sonoma	157,988
Stanislaus	298,847
Sutter	11,900
Tehama	30,334
Trinity	359,503
Tulare	178,613
Tuolumne	264,979
Ventura	14,558,096
Yolo	16,823
Yuba	1,150,962
Total	$206,489,058

MUSEUM

The Museum of the State Division of Mines possesses an exceptionally fine collection of rocks and minerals of both economic and academic value. It ranks among the first five of such collections in North America and contains not only specimens of most of the known minerals found in California, but much valuable and interesting material from other States and foreign countries as well.

Mineral specimens suitable for exhibit purposes are solicited, and their donation will be appreciated by the State Division of Mines as well as by those who utilize the facilities of the collection.

The exhibit is daily visited by engineers, students, business men, and prospectors as well as tourists and mere sightseers. Beside its practical use in the economic development of California's mineral resources, the collection is a most valuable educational asset to the State and to San Francisco.

During 1933 there were 54,825 people who visited the Museum and Library of the Division of Mines in San Francisco. Among these there were many men who were forced by conditions to find new means of livelihood, and resorted to prospecting. They were able to observe here how all minerals, ores and rocks appear, thereby having a better knowledge of what they will find in the hills; also what minerals and rocks look like as described in various reports and books.

LABORATORY .

FRANK SANBORN, Mineral Technologist

The laboratory of the Division of Mines is maintained for the purpose of identifying minerals and making qualitative analyses of rocks. These determinations and analyses are made without cost to those who seek the services of this State department. Ordinarily, a small sample weighing not over half a pound, in the lump form if possible, should be submitted with a letter stating what particular tests are desired, if there is a special reason for sending the material. Not more than three samples should be sent at one time, nor is it necessary to send more than one. Information regarding the size of the deposit and its proximity to rail transportation is useful in determining the possible value of a mineral body.

When requested, assistance in finding a market for a mineral will be given. When such help is desired, a small representative sample of the material for which a market is sought should accompany the request. The Division is sometimes able to send a very small sample of a particular mineral for comparative purposes to any earnest prospector. Prospecting and exploitation of the State's mineral wealth increases as the State becomes more thickly populated. Each year new occurrences of some mineral in the State are reported and occasionally a new mineral species is found. New uses for a mineral are frequently found, and as a result stimulus is given to searching for that particular substance.

LIBRARY

HERBERT A. FRANKE, Librarian

In addition to the numerous standard works, authoritative information on many phases of the mining and mineral industry is constantly being issued in the form of reports and bulletins by various government agencies.

The library of the Division of Mines contains over six thousand selected volumes on mines, mining and allied subjects, and it is also a repository for reports and bulletins of the technical departments of Federal and State governments and of educational institutions, both domestic and foreign.

It is not the dearth of the latter publications, but rather a lack of knowledge of just what has been published and where the reports may be consulted or obtained, that embarrasses the ordinary person seeking specific information.

To assist in making the public acquainted with this valuable source of current technical information, California Journal of Mines and Geology contains under this heading a list of all books and official reports and bulletins received, with names of publishers or issuing departments.

Files of all the leading technical journals will be found in the library, and county and State maps, topographical sheets and geological folios. Current copies of local newspapers published in the mining centers of the State are available for reference.

The library and reading room are open to the public during the usual office hours, when the librarian may be freely called upon for all necessary assistance.

OFFICIAL PUBLICATIONS RECEIVED

Government, National

U. S. Geological Survey:

Bulletins:

849D—The Mount Eilson District, Alaska. By J. C. Reed.
850 —Quicksilver Deposits of Southwestern Oregon. By F. G. Wells and A. C. Waters.
857C—The Curry District, Alaska. By R. Tuck.
857D—Notes on the Geology of the Alaska Peninsula and Aleutian Islands. By S. R. Capps.

Professional Papers:

176—Geology and Ore Deposits of the Breckenridge Mining District, Colorado. By T. S. Lavering.

Water Supply Papers:

658—The Industrial Utility of Public Water Supplies in the U. S., 1932.
728—Part 2—Ohio River Basin.
738—Part 12—North Pacific Slope Basins.
740—Surface Water Supply of Hawaii.

Circulars:

9—Geology and Ore Deposits of the Elk City, Orogrande, Buffalo Hump and Tenmile Districts, Idaho County, Idaho. By Shenon and Reed.
10—The McCoy Mining District and Gold Veins in Horse Canyon, Lander Co., Nevada. By F. C. Schrader.
11—Review of the Petroleum Industry in the U. S., April, 1934. Compiled by H. B. Soyster.

U. S. Bureau of Mines:

Bulletins:

371—High-Temperature Specific-Heat Equations for Inorganic Substances. By K. K. Kelley.
372—Accounting System and Office Management Procedure for Medium-Size Metal Mines. By A. E. Keller.
378—Underfeed Combustion, Effect of Pre-heat, and Distribution of Ash in Fuel Beds. By P. Nicholls.
380—Coal-Mine Accidents in the U. S., 1932. By W. W. Adams and L. E. Geyer.

Report of Investigations:

3228—Progress Reports—Metallurgical Division: 3. Studies in the Metallurgy of Copper. By R. S. Dean, F. S. Wartman, A. J. Thompson, E. K. Pryor, J. D. Sullivan, G. L. Oldright, A. F. Hallet, S. L. Brown, W. A. Sloan and C. W. Davis.
3229—Progress Reports—Metallurgical Division: 4. Studies in Direct Production of Iron and Steel from Ore. By R. S. Dean, S. R. B. Cooke, John Gross, C. W. Davis, C. G. Maier, S. B. Thomas, E. P. Barrett, T. L. Joseph, C. E. Wood, G. R. Fitterer, H. Freeman, V. H. Gottschalk and Donald Doan.
3230—Solubility of Carbon in Iron-Manganese-Silicon Alloys. By C. H. Herty, Jr., and M. B. Royer.
3231—Dry Cells and Their Application to Mining. By A. B. Hooker and E. J. Coggeshall.
3232—Temperature-Viscosity Measurement in the Systems $CaO-SiO_2$ and $CaO-SiO_2-CaF_2$. By G. H. Herty, Jr., F. A. Hartgen, G. L. Frear and M. B. Royer.
3233—The Occurrence of Gases in Coals. By R. F. Selden.
3234—Table Cleaning of Fine Coal from the Thompson and Woodstock Beds of the Cahaba Field, Alabama. By A. C. Richardson, B. W. Gandrud and W. D. Musgrove.
3235—Some Physical Properties and Characteristics of Fuse. By N. A. Tolch and J. E. Tiffany.
3236—Detailed Statistical Microscopic Analyses of the Ore and Mill Products of the Silver King Flotation Concentrator, Park City, Utah. By R. E. Head, Arthur L. Crawford, F. E. Thackwell and Glen Burgener.
3237—A Study of the Properties of Texas-New Mexico Polyhalite Pertaining to the Extraction of Potash. VIII. Removal of Sodium Chloride from Crude Polyhalite by Washing. By J. M. Davidson and F. Fraas.
3238—Summary of Experimental Data on Laboratory Oxidation of Crude Oils, with particular reference to air-repressuring. By Sam S. Taylor and H. M. Smith.
3239—Progress Reports—Metallurgical Division. 5. Ore-Dressing Studies. By W. H. Goghill, F. D. DeVaney, J. Bruce Clemmer and R. G. O'Meara.
3240—Progress Reports—Metallurgical Division. 6. Size Preparation of Iron Ores and Desulphurization Studies. By T. L. Joseph and W. F. Holbrook.
3241—Formulas for Designing Natural-Gas Pipe-Line Systems Consisting of Parallel Lines. By T. W. Johnson and W. B. Berwald.
3249—Chemical Method for Removing Mud Sheaths in Oil Wells. By H. C. Miller and G. B. Shea.
3251—Engineering Studies and Results of Acid Treatment of Wells. Zwolle Oil Field, Sabine Parish, La. By R. E. Heithecker.
3250—A Thermal Conductivity Apparatus for Continuous Determination of the Helium Content of Natural Gas. By Allen S. Smith.
3254—The National Safety Competition of 1933. By W. W. Adams.
3259—Active List of Permissible Explosives and Blasting Devices Approved Prior to June 30, 1934. By (no name given),

Information Circulars:

6768—Manganese: Its Occurrence, Milling, and Metallurgy. Part I.
Chapter 1. Physical Properties and Preparation of Metallic Manganese.
Chapter 2. Manganese in nonferrous alloys.
Chapter 3. Compounds of Manganese.
Chapter 4. Occurrence and Ore-Dressing Possibilities of Ores of Manganese in the U. S.
By R. S. Dean, Fred D. DeVaney and Will H. Coghill.

6769—Manganese: Its Occurrence, Milling, and Metallurgy. Part II.
Chapter 5. Thermodynamic Properties of Manganese, and its Metallurgically important Compounds.
By C. G. Maier.

6770—Manganese: Its Occurrence, Milling, and Metallurgy. Part III.
Chapter 6. General Metallurgy of Manganese.
Chapter 7. Hydrometallurgy of Manganese.
Chapter 8. Pyrometallurgical Treatment of Manganese Ores.
By R. S. Dean, Edmund S. Leaver and T. L. Joseph.

6771—Manganese: Its Occurrence, Milling, and Metallurgy. Part IV.
Chapter 9. Ferrous Alloys of Manganese and their use in the Steel Industry.
By G. R. Fitterer and M. B. Royer.

6772—Manganese: Its Occurrence, Milling, and Metallurgy. Part V.
Chapter 10. Bibliography.
Chapter 11. Indexes, by Mable E. Winslow.
6775—How can the Bureau of Mines best serve Mining? (The Bureau and the South.) By Milton H. Fies.
6777—Mining Laws of British Guiana. By E. P. Youngman.
6778—Mining Laws of British Honduras. By E. P. Youngman.
6779—The Iron Blast Furnace. By T. L. Joseph.
6780—Meerschaum. By Alice V. Petar.
6781—Calcium Chloride. By Paul M. Tyler.
6782—Greensand. By Paul M. Tyler.
6783—Mining Anthracite without Roof-Fall Accidents at Colonial Colliery, Colonial Colliery Co., Natalie, Pa. By R. D. Currie.
6784—Ore-Dressing Bibliography, 1931–1932. By T. H. Miller and R. L. Kidd.
6785—Summary of Ore-Mining Cost Data. By Chas. F. Jackson.
6789—Amber. By Alice V. Petar.
6790—Asbestos—Domestic and Foreign Deposits. By Oliver Bowles.
6791—Accident Experience and Cost in Wyoming Coal Mines. By D. J. Parker.
6793—A Million Tons of Anthracite Mined Without a Fatality. By R. D. Currie.
6795—Mining Limestone by a Caving Method at Crestmore Mine of the Riverside Cement Co., Crestmore, Calif. By C. A. Robotham.
6796—An Apparatus and Method for the Determination of Helium in Natural Gas. By C. C. Anderson.
6797—The Use of Treated Mine Ties and Timbers in Illinois and Indiana Coal Mines. By C. A. Herbert.
6800—Mining and Milling Practices at Small Gold Mines. By E. D. Gardner and C. H. Johnson.
6803—Value of the Cooperative Method in First-Aid Training. By J. J. Forbes.
6807—Petroleum Refineries, Including Cracking Plants, in the United States, January 1, 1934. By G. R. Hopkins and E. W. Cochrane.

Technical Papers:

551—Safety at Petroleum Cracking Plants. By R. L. Marek.
557—Accidents at Metallurgical Works in the U. S., 1932. By W. W. Adams.

Government, State

Arizona Bureau of Mines, Tucson:

Bulletin 136—Field Tests for the Common Metals. By G. R. Fansett.
Bulletin 137—Arizona Lode Gold Mines and Gold Mining. By Wilson, Cunningham, and Butler.

Idaho Bureau of Mines and Geology, Moscow:

Pamphlet No. 38—Biennial Report on the Activities of the Bureau. By J. W. Finch.

Illinois Geological Survey, Urbana:

P. B. No. 25—Oil and Gas Development in Illinois in 1933.
P. B. No. 61—Rock Wool from Illinois Mineral Resources.

Montana Bureau of Mines and Geology, Butte:
Memoir No. 12—Physiography and Ground Water Supply in the Big Hole Basin, Montana. By E. S. Perry.

Nevada State Bureau of Mines, Reno:
Vol. XXVIII, No. 5—Outline of Plan to Rehabilitate the State Bureau of Mines and the Cooperation Work With the U. S. G. S.

New Mexico Bureau of Mines and Mineral Resources, Socorro:
Bulletin 10—Geology and Ore Deposits of Sierra County, New Mexico. By G. T. Harley.

Pennsylvania Geological Survey, Harrisburg:
Fourth Series:
Bulletin W 2—Groundwater in Southeastern Pennsylvania. By G. M. Hall.
Bulletin G 6—The Scenery of Pennsylvania. By G. H. Ashley.
Bulletin M19—Contributions to Oil and Gas Geology of Western Pennsylvania.
Bulletin M20—Limestones of Pennsylvania. By B. L. Miller.

South Dakota, State Geological Survey, Vermillion:
R. I. No. 18—Water Supplies at Fort Thompson, S. D. By E. P. Rothrock.
R. I. No. 19—South Dakota Statutes Governing Mineral Resources.
R. I. No. 20—Geology of Grant County, South Dakota. By E. P. Rothrock.

Tennessee Division of Geology, Nashville:
Bulletin 39—Brown Iron Ores of the Western Highland Rim, Tennessee.

Wyoming Geological Survey, Cheyenne:
R. I. No. 1—Saline Lake Deposits of Wyoming. The Downey Lakes, Wyoming. By S. H. Knight.
Bulletin No. 24—Geology of the Western End of the Owl Creek Mountains, Wyoming. By D. Love.
Bulletin No. 25—Geology of the North End of the Medicine Bow Mountains, Carbon County, Wyoming. By J. Neely.

Philippine Bureau of Science, Manila.
The Mineral Resources of the Philippine Islands for the years 1924 and 1925.

Quebec Bureau of Mines, Quebec:
Annual Report Part B, 1932.
Annual Report Part D, 1932.

Queensland Department of Mines, Brisbane, Australia:
Annual Reports.

Instituto Historica e Geographico, Brasilerio de Janeiro:
Publications.

New South Wales Department of Mines, Sydney, Australia:
Annual Reports.

Transvaal Chamber of Mines, Johannesburg, So. Africa:
Publications.

Geological Service of Minas Geraes, Bello Horizonte, Brazil:
Publications.

Government, Foreign

Alberta Research Council, Edmonton:
Annual Reports.

Argentina Direccion General de Minas y Geologica, Buenos Aires:
Publications.

South Australia Department of Mines, Adelaide:
Annual Reports, Mining Reviews, etc.

Brazil Ministerio da Agricultura da Brazil, Rio de Janeiro:
Reports.

British Columbia Department of Mines, Victoria:
Bulletin No. 1—Placer Mining in B. C., 1933.

British Columbia Minister of Mines, Victoria:
Annual Report, 1933.

Canada Department of Mines, Ottawa:
  Annual Report for 1933 of National Museum of Canada.

  Economic Geology Series No. 13—Platinum and Allied Metal Deposits of Canada. By O'Neill & Gunning.

Investigations in Ore Dressing and Metallurgy, 1932.

Investigations of Mineral Resources and the Mining Industry, 1932.

Limestones of Canada, Part II—Maritime Provinces. By M. F. Goudge.

Memoir 171—Geology and Ore Deposits of Copper Mountain, B. C. By V. Dolmage.

Memoir 172—Geology and Mineral Deposits of Solino Map Area, B. C. By J. F. Walker.

  Summary Reports, 1933.

Geological Survey of Great Britain, London:

  Memoirs, Geologic Maps, etc.

Museo de Historia Natural de Montevideo, Uruguay:
  Analas.

Secretaria de Industria, Comercio y Trabajo, Mexico, D. F.:
  Boletin Minero.
  Boletin del Petroleo.

New Zealand Geological Survey, Wellington.

  Bulletin No. 34—Geology of the Dargaville-Rodney Subdivision. By H. Ferrar.

Nova Scotia Department of Public Works and Mines, Halifax:
  Annual Reports.

Ontario Department of Mines, Toronto:
  42d Annual Report, 1933.

  Bulletin 92—Preliminary Report on the Mineral Production of Ontario in 1933.

  Bulletin 93—Money and the World Crisis, No. 2. By H. S. Denny.

  Bulletin 94—Mines and Metallurgical Works of Ontario in 1933.

Societies and Educational Institutions

Academia de Ciencias y Artes de Barcelona, Spain:
  Memoiras.

Academy of Natural Sciences of Philadelphia:
  Proceedings.

American Association of Petroleum Geologists, Tulsa, Oklahoma:
  Bulletins.

American Geographical Society of New York:
  "Geographical Review."

  American Journal of Science, New Haven, Conn.

American Philosophical Society, Philadelphia:
  Proceedings.

Australian Museum, Sydney:
  Records.

California Academy of Sciences, San Francisco:
  Proceedings.

Canadian Institute of Mining and Metallurgy, Montreal:
  "Canadian Mining and Metallurgical Bulletin."

Cleveland Museum of Natural History, Cleveland, Ohio:
  Scientific Publications.

Colorado College Publication, Colorado Springs.

Colorado Scientific Society, Denver:
  Proceedings.

Commonwealth Club, San Francisco:
  Journals.

Economic Geology, Lancaster, Pa.

Field Museum of Natural History, Chicago:
  Geological Series.

Franklin Institute of the State of Pennsylvania, Lancaster, Pa.:
  Journals.

Geological Society of America, Columbia University, New York:
  Bulletins.

Geological Society of London:

  Abstracts of the Proceedings.

Institution of Mining and Metallurgy, London:
  Bulletins, Transactions.

Instituto Geologico de Mexico, Mexico, D. F.:
  Bulletins.

Journal of Geology, Chicago.

Library of Congress, Washington, D. C.:
  Monthly Check List of State Publications.

Mineralogical Society of America, Menasha, Wisconsin:
  "The American Mineralogist."

Mining and Metallurgical Society of America, New York:
  Bulletins.

Museu Nacional, Rio de Janeiro:
  Boletins.

National Research Council, Washington, D. C.:
  Annual Report for 1932–1933.
  Catalogue of Small-Scale Geologic Maps.
  Problems of Batholiths.

New York Academy of Sciences, New York:
  Annals, etc.

New York State Museum, Albany:
  Publications.

Northwest Scientific Association, Cheney, Wash.:
  "Northwest Science."

Pacific Mineralogist, Los Angeles.

Pennsylvania State College, State College:
  Bulletins.

Philippine Journal of Science, Manila.

Royal Society of South Australia, Adelaide:
  Transactions and Proceedings.

Secretario de la Economia Nacional, Mexico, D. F.:
  Revista Industrial.

Seismological Society of America, Stanford University:
  Bulletins.

Sierra Club, San Francisco:
  Bulletin.

Society of Economic Paleontologists and Mineralogists, Ft. Worth, Texas:
  "Journal of Paleontology."

Southern California Academy of Sciences, Los Angeles:
  Bulletins.

Books

Directory of Mines of the Western States. By Mining Review.
The Mineral Industry during 1933. Vol. 42, Edited by G. A. Roush.
Petroleum Production Engineering. By L. C. Uren.
The Triumph of an Idea. (The Story of Henry Ford.) By R. H. Graves.
Wilson's Mining Laws, 1934.

John Hays Hammond Public Mining Library:

Applied Geophysics in the Search for Minerals. By A. S. Eve and D. A. Keys.
A Golden Highway. By G. B. Glasscock.
Prospecting for Gold and Silver. By Savage.
The Saga of the Comstock Lode. By G. D. Tyman.

Maps

U. S. Geological Survey Topographic Maps:

- California:
  - Fairmont Quadrangle, Los Angeles Co.
  - Halls Flat Quadrangle, Kings Co.
  - Kettleman City Quadrangle, Kings Co.
  - La Brun Quadrangle, Los Angeles Co.
  - La Cima Quadrangle.
  - Lakeport Quadrangle.
  - Los Viejos Hills Quadrangle, Kings Co.
  - Palmdale Quadrangle, Los Angeles Co.
- Colorado:
  - Dillon Quadrangle.
  - Minturn Quadrangle.
- Idaho:
  - Buffalo Hump Quadrangle.
- Illinois-Missouri:
  - Alton Quadrangle.
- Missouri:
  - Advance Quadrangle.
- Oregon:
  - Dalles Quadrangle.
  - Dufur Quadrangle.
- Texas:
  - La Coma Quadrangle.
  - Port Isabel Quadrangle.

Current Magazines on File

For the convenience of persons wishing to consult the technical magazines in the reading room, a list of those on file is appended:

Asbestos, Philadelphia, Pennsylvania.
Brick and Clay Record, Chicago.
California Journal of Development, San Francisco.
California Mining Journal, Auburn.
California Oil World, Los Angeles.
California Safety News, San Francisco.
Canadian Mining Journal, Gardenvale, Quebec.
Chemical and Metallurgical Engineering, New York City.
Chemical Engineering and Mining Review, Melbourne, Australia.
Commonwealth, San Francisco.
Colorado School of Mines, Golden, Colorado.
Engineering and Mining Journal, New York City.
Fuel Oil, Chicago, Illinois.
Fusion Facts, Whittier, California.
Geophysical Prospector, Los Angeles.
Gold, Toronto, Canada.
Grizzly Bear, Los Angeles.
Hercules Mixer, Wilmington, Delaware.
Independent Monthly, Tulsa, Oklahoma.
Lubrication, The Texas Co., New York City.
Metals and Alloys, Pittsburgh, Pa.

Mining Congress Journal, Washington, D. C.
Mining Journal, London.
Mining Journal, Phoenix, Arizona.
Mining and Metallurgy, New York City.
Mining Review, Salt Lake City.
Mining Truth, Spokane, Washington.
National Sand and Gravel, Washington, D. C.
Nickel Cast Iron News, New York City.
Oil and Gas Journal, Tulsa, Oklahoma.
Oil, Paint and Drug Reporter, New York City.
Oil Weekly, Houston, Texas.
Oregon Mineralogist, Portland, Ore.
Pacific Purchaser, San Francisco.
Petroleum World, Los Angeles.
Pit and Quarry, Chicago.
Queensland Government Mining Journal, Brisbane, Australia.
Rock Products, Chicago.
Rocks and Minerals, Peekskill, New York.
Scientific American, New York City.
Southwest Builder and Contractor, Los Angeles.
Stabilizer, Los Angeles.
Standard Oil Bulletin, San Francisco.
Stone, New York City.
Western Mining News, San Francisco.

Newspapers

The following papers are received and kept on file in the library:

Amador Dispatch, Jackson, California.
Banner, Sonora, California.
Barstow Printer, Barstow, California.
Bridgeport Chronicle-Union, Bridgeport, California.
Calaveras Californian, Angels Camp, California.
Calaveras Prospect, San Andreas, California.
Daily Commercial News, San Francisco, California.
Daily Midway Driller, Taft, California.
Del Norte Triplicate, Crescent City, California.
Denver Mining Record, Denver, Colorado.
Georgetown Gazette, Georgetown, California.
Inland Oil Index, Casper, Wyoming.
Inyo Independent, Independence, California.
Inyo Register, Bishop, California.
Las Vegas Age, Las Vegas, Nevada.
Livermore Herald, Livermore, California.
Mariposa Gazette, Mariposa, California.
Mercury Register, Oroville, California.
Mining & Industrial News, San Francisco, California.
Mojave Miner, Kingman, Arizona.
Mojave-Randsburg Record, Mojave, California.
Morning Union, Grass Valley, California.
Mountain Messenger, Downieville, California.
National Industrial Review, San Francisco, California.
Needles Nugget, Needles, California.
Nevada City Nugget, Nevada City, California.
Nevada Mining Bulletin, Las Vegas, Nevada.
Northern Miner, Toronto, Canada.
Oil Marketer, Bayonne, New Jersey.
Placer Herald, Auburn, California.
Plumas Independent, Quincy, California.
San Diego News, San Diego, California.
Shasta Courier, Redding, California.
Siskiyou News, Yreka, California.
Stockton Record, Stockton, California.
Tehachapi News, Tehachapi, California.
Terra Bella News, Terra Bella, California.
Tuolumne Independent, Sonora, California.
Tuolumne Prospector, Tuolumne, California.
Union Democrat, Sonora, California.
Ventura County News, Ventura, California.
Waterford News, Waterford, California.
Weekly Trinity Journal, Weaverville, California.
Western Mineral Survey, Salt Lake City, Utah.
Western Sentinel, Etna Mills, California.

PRODUCERS AND CONSUMERS

The producer and consumer of mineral products are mutually dependent upon each other for their prosperity, and one of the most direct aids rendered by this Division to the mining industry in the past has been that of bringing producers and consumers into direct touch with each other.

This work has been carried on largely by correspondence, supplemented by personal consultation. Lists of buyers of all the commercial minerals produced in California have been made available to producers upon request, and likewise the owners of undeveloped deposits of various minerals, and producers of them, have been made known to those looking for raw mineral products.

When the publication of *Mining in California* was on a monthly basis, current inquiries from buyers and sellers were summarized and lists of mineral products or deposits 'wanted' or 'for sale' included in each issue.

It is important that inquiries of this nature reach the mining public as soon as possible and in order to avoid the delay incident to the present quarterly publication of CALIFORNIA JOURNAL OF MINES AND GEOLOGY, these lists are now issued monthly in the form of a mimeographed sheet under the title of 'Commercial Mineral Notes,' and sent to those on the mailing list of CALIFORNIA JOURNAL OF MINES AND GEOLOGY.

EMPLOYMENT SERVICE

Following the establishment of the Mining Division branch offices in 1919, a free technical employment service was offered as a mutual aid to mine operators and technical men for the general benefit of the mineral industry.

Briefly summarized, men desiring positions are registered, the cards containing an outline of the applicant's qualifications, position wanted, salary desired, etc., and as notices of 'positions open' are received, the names and addresses of all applicants deemed qualified are sent to the prospective employer for direct negotiations.

Telephone and telegraphic communications are also given immediate attention.

Technical men, or those qualified for supervisory positions, and vacancies of like nature only, are registered, as no attempt will be made to supply common mine and mill labor.

Registration cards for the use of both prospective employers and employees may be obtained upon request, and a cordial invitation is extended to the industry to make free use of the facilities afforded. Parties interested should communicate direct with our San Francisco office.

PUBLICATIONS OF THE DIVISION OF MINES

During the past fifty-four years, in carrying out the provisions of the organic act creating the former California State Mining Bureau, there have been published many reports, bulletins and maps which go to make up a library of detailed information on the mineral industry of the State, a large part of which could not be duplicated from any other source.

One feature that has added to the popularity of the publications is that many of them have been distributed without cost to the public, and even the more elaborate ones have been sold at a price which barely covers the cost of printing.

Owing to the fact that funds for the advancing of the work of this department have usually been limited, the reports and bulletins mentioned are printed in limited editions many of which are now entirely exhausted.

Copies of such publications are available, however, in the offices of the Division of Mines, in the Ferry Building, San Francisco; State Building, Los Angeles; State Office Building, Sacramento; Redding; and Division of Oil and Gas at Santa Barbara, Santa Paula, Coalinga, Taft, Bakersfield. They may also be found in many public, private and technical libraries in California and other States and foreign countries.

A catalog of all publications from 1880 to 1917, giving a synopsis of their contents, is issued as Bulletin No. 77.

Publications in stock may be obtained by addressing any of the above offices and enclosing the requisite amount in the case of publications that have a list price. Only coin, stamps or money orders should be sent, and it will be appreciated if remittance is made in this manner rather than by personal check.

Money orders should be made payable to the Division of Mines.

NOTE.—The Division of Mines frequently receives requests for some of the early Reports and Bulletins now out of print, and it will be appreciated if parties having such publications and wishing to dispose of them will advise this office.

REPORTS

Asterisks (**) indicate the publication is out of print.

	Price	Shipping Charges
**First Annual Report of the State Mineralogist, 1880, 43 pp. Henry G. Hanks	----	----
**Second Annual Report of the State Mineralogist, 1882, 514 pp., 4 illustrations, 1 map. Henry G. Hanks	----	----
**Third Annual Report of the State Mineralogist, 1883, 111 pp., 21 illustrations. Henry G. Hanks	----	----
**Fourth Annual Report of the State Mineralogist, 1884, 410 pp., 7 illustrations. Henry G. Hanks	----	----
**Fifth Annual Report of the State Mineralogist, 1885, 234 pp., 15 illustrations, 1 geological map. Henry G. Hanks	----	----
**Sixth Annual Report of the State Mineralogist, Part I, 1886, 145 pp., 3 illustrations, 1 map. Henry G. Hanks	----	----
**Part II, 1887, 222 pp., 36 illustrations. William Irelan, Jr.	----	----
**Seventh Annual Report of the State Mineralogist, 1887, 315 pp. William Irelan, Jr.	----	----
**Eighth Annual Report of the State Mineralogist, 1888, 948 pp., 122 illustrations. William Irelan, Jr.	----	----
**Ninth Annual Report of the State Mineralogist, 1889, 352 pp., 57 illustrations, 2 maps. William Irelan, Jr.	----	----
**Tenth Annual Report of the State Mineralogist, 1890, 983 pp., 179 illustrations, 10 maps. William Irelan, Jr.	----	----
Eleventh Report (First Biennial) of the State Mineralogist, for the two years ending September 15, 1892, 612 pp., 73 illustrations, 4 maps. William Irelan, Jr.	$1.00	$0.20
**Twelfth Report (Second Biennial) of the State Mineralogist, for the two years ending September 15, 1894, 541 pp., 101 illustrations, 5 maps. J. J. Crawford	----	----
**Thirteenth Report (Third Biennial) of the State Mineralogist, for the two years ending September 15, 1896, 726 pp., 93 illustrations, 1 map. J. J. Crawford	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1913–1914, Fletcher Hamilton:		
**Mines and Mineral Resources, Amador, Calaveras and Tuolumne Counties, 172 pp., paper	----	----
Mines and Mineral Resources, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma and Yolo Counties, 208 pp., paper	.50	.10
**Mines and Mineral Resources, Del Norte, Humboldt and Mendocino Counties, 59 pp., paper	----	----
**Mines and Mineral Resources, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin and Stanislaus Counties, 220 pp., paper	----	----
**Mines and Mineral Resources of Imperial and San Diego Counties, 113 pp., paper	----	----
**Mines and Mineral Resources, Shasta, Siskiyou and Trinity Counties, 180 pp., paper	----	----
**Fourteenth Report of the State Mineralogist, for the Biennial Period 1913–1914, Fletcher Hamilton, 1915: A General Report on the Mines and Mineral Resources of Amador, Calaveras, Tuolumne, Colusa, Glenn, Lake, Marin, Napa, Solano, Sonoma, Yolo, Del Norte, Humboldt, Mendocino, Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, Stanislaus, San Diego, Imperial, Shasta, Siskiyou and Trinity Counties, 974 pp., 275 illustrations, cloth	----	----
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**Mines and Mineral Resources, El Dorado, Placer, Sacramento and Yuba Counties, 198 pp., paper	----	----
Mines and Mineral Resources, Monterey, San Benito, San Luis Obispo, Santa Barbara and Ventura Counties, 183 pp., paper	.65	.10
**Mines and Mineral Resources, Los Angeles, Orange and Riverside Counties, 136 pp., paper	----	----
**Mines and Mineral Resources. San Bernardino and Tulare Counties, 186 pp., paper	----	----

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**Fifteenth Report of the State Mineralogist, for the Biennial Period 1915–1916, Fletcher Hamilton, 1917: A General Report on the Mines and Mineral Resources of Alpine, Inyo, Mono, Butte, Lassen, Modoc, Sutter, Tehama, Placer, Sacramento, Yuba, Los Angeles, Orange, Riverside, San Benito, San Luis Obispo, Santa Barbara, Ventura, San Bernardino and Tulare Counties, 990 pp., 413 illustrations, cloth	----	----
Chapters of the State Mineralogist's Report, Biennial Period, 1917–1918, Fletcher Hamilton:		
**Mines and Mineral Resources of Nevada County, 270 pp., paper	----	----
Mines and Mineral Resources of Plumas County, 188 pp., paper	$0.50	$0.10
Mines and Mineral Resources of Sierra County, 144 pp., paper	.50	.10
Seventeenth Report of the State Mineralogist, 1920, 'Mining in California during 1920,' Fletcher Hamilton; 562 pp., 71 illustrations, cloth	1.75	.25
Eighteenth Report of the State Mineralogist, 1922, 'Mining in California,' Fletcher Hamilton. Chapters published monthly beginning with January, 1922:		
**January, **February, **March, **April, **May, **June, July, August, September, October, **November, December, 1922	.25	.05
Chapters of Nineteenth Report of the State Mineralogist, 'Mining in California,' Fletcher Hamilton and Lloyd L. Root. January, February, March, September, 1923	.25	.05
Chapters of Twentieth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly. January, April, **July, October, 1924, per copy	.25	.05
Chapters of Twenty-first Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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Chapters of Twenty-second Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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Chapters of Twenty-fourth Report of the State Mineralogist, 'Mining in California,' Lloyd L. Root. Published quarterly:		
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Chapters of Twenty-fifth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
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July, 1930, Mines and Mineral Resources of Yuba and San Bernardino Counties; also Commercial Grinding Plants in California	.25	.10
October, 1930, Mines and Mineral Resources of Butte, Kings and Tulare Counties; also Geology of Southwestern Mono County (Preliminary)	.25	.10
Chapters of Twenty-seventh Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1931, Preliminary Report on Economic Geology of the Shasta Quadrangle. Beryllium and Beryl. The New Tariff and Nonmetallic Products. Crystalline Talc. Decorative Effects in Concrete	.25	.10
April, 1931, Stratigraphy of the Kreyenhagen Shale. Diatoms and Silicoflagellates of the Kreyenhagen Shale. Foraminifera of the Kreyenhagen Shale. Geology of Santa Cruz Island	.25	.10
July, 1931. (Yuba, San Bernardino.) Feldspar, Silica, Andalusite and Cyanite Deposits of California. Note on a Deposit of Andalusite in Mono County: its occurrence and chemical importance. Bill creating Trinity and Klamath River Fish and Game District and its effect upon mining	.25	.10
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Chapters of Twenty-eighth Report of the State Mineralogist, 'Mining in California,' Walter W. Bradley. Published quarterly:		
January, 1932, Economic Mineral Deposits of the San Jacinto Quadrangle. Geology and Physical Properties of Building Stone from Carmel Valley. Contributions to the Study of Sediments. Sediments of Monterey Bay. Sanbornite	.25	.10
**April, 1932. Elementary Placer Mining Methods and Gold Saving Devices. The Pan, Rocker and Sluice Box. Prospecting for Vein Deposits. Bibliography of Placer Mining	----	----
Abstract from April quarterly: Elementary Placer Mining Methods and Gold Saving Devices. Types of Deposits. Simple Equipment. Special Machines. Dry Washing. Black Sand Treatment. Marketing of Products. Placer Mining Areas. Laws. Prospecting for Quartz Veins. Bibliography (mimeographed)	.20	.05
July-October. (Ventura.) Report accompanying Geologic Map of Northern Sierra Nevada. Fossil Plants in Auriferous Gravels of the Sierra Nevada. Glacial and Associated Stream Deposits of the Sierra Nevada. Jurassic and Cretaceous Divisions in the Knoxville-Shasta Succession of California. Geology of a Part of the Panamint Range. Economic Report of a Part of the Panamint Range. Acquiring Mining Claims Through Tax Title. The Biennial Report of State Mineralogist	.50	.15
Chapters of Report XXIX, 1933 (quarterly): titled "California Journal of Mines and Geology." containing the following:		
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*Bulletin No. 10. A bibliography Relating to the Geology, Paleontology and Mineral Resources of California, by Anthony W. Vogdes. 1896, 121 pp.	----	----
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*Bulletin No. 14. Mineral Production of California, by Counties, for 1898, by Charles G. Yale	----	----
*Bulletin No. 15. Map of Oil City Fields, Fresno County, by John H. Means, 1899	----	----
*Bulletin No. 16. The Genesis of Petroleum and Asphaltum in California, by A. S. Cooper. 1899, 39 pp., 29 illustrations	----	----
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**Bulletin No. 42. Mineral Production of California, by Counties, 1905, by Charles G. Yale. Tabulated sheet	----	----
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**Bulletin No. 44. California Mines and Minerals for 1905, by Charles G. Yale. 1907, 31 pp., 20 county maps	----	----
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PRELIMINARY REPORTS

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Samples (limited to one at one time) of any mineral found in the State may be sent to the Division of Mines for identification, and the same will be classified free of charge. No samples will be determined if received from points outside the State. It must be understood that no assays, or quantitative determinations will be made. Samples should be in lump form if possible, and marked plainly with name of sender on outside of package, etc. No samples will be received unless delivery charges are prepaid. A letter should accompany sample, giving locality where mineral was found and the nature of the information desired.

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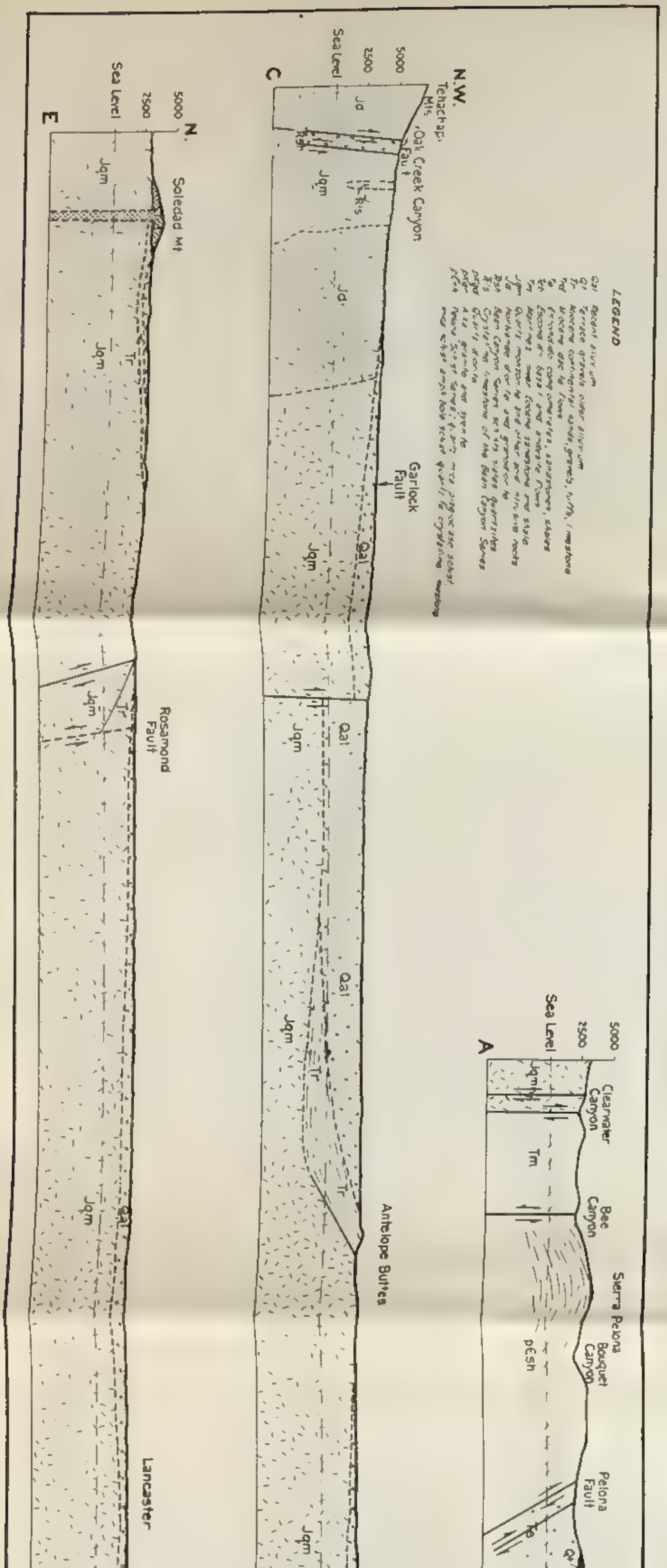
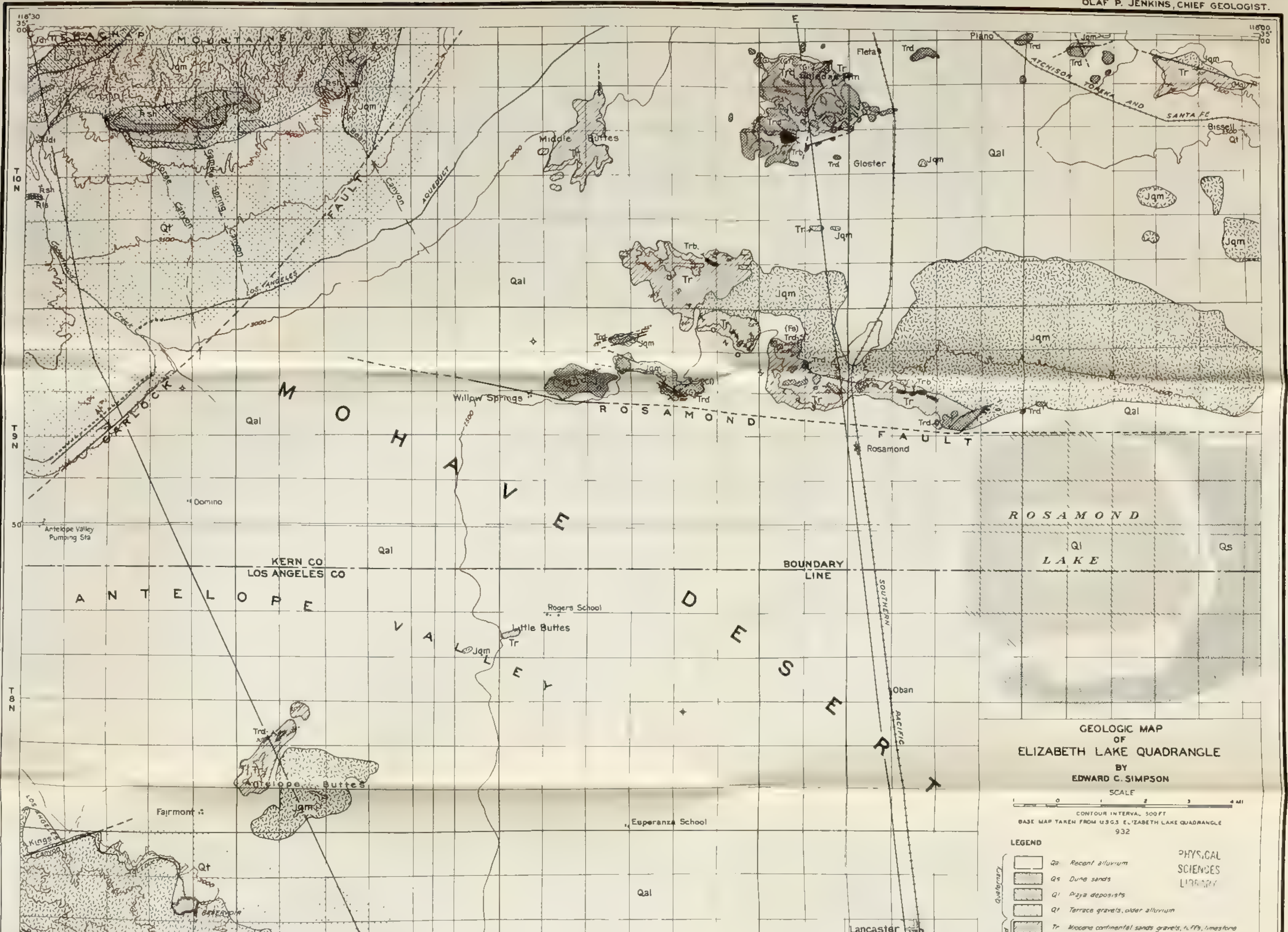
PLATE V.

GEOLOGIC BRANCH
OLAF P. JENKINS, CHIEF GEOLOGIST.


N.W.
Tehachapi Mt.
Oak Creek Canyon
Garlock Fault
Rosamond Fault
Antelope Buttes
Portal Ridge
San Andreas Rift
Bouquet Canyon
Sierra Pelona
Pelona Fault
S.E.
N
Soledad Mt.
Lancaster
Palmdale
S
Clearwater Canyon
Bee Canyon
Sierra Pelona
Bouquet Canyon
Pelona Fault
A
B
C
D
E
F
5000
2500
Sea Level
Jqm
Jd
Qal
Tr
Tm
pCsh
Te
pKqd
HORIZONTAL SCALE
VERTICAL SCALE
LEGEND


TEHACHAPI MOUNTAINS
GARLOCK
FAULT
MOHAVE DESERT
ANTELOPE VALLEY
ROSAMOND FAULT
ROSAMOND LAKE
Willow Springs
Rosamond
Middle Buttes
Soledad Mtn
Gloster
Fleta
Piano
ATCHISON TOPEKA AND SANTA FE
Bissell
Domino
Antelope Valley Pumping Sta
KERN CO
LOS ANGELES CO
BOUNDARY LINE
Rogers School
Little Buttes
Oban
Antelope Buttes
Fairmont
Esperanza School
Lancaster
Del Sur
Quartz Hill
Denis
Belleview School
SOUTHERN PACIFIC
SAN FRANCISCO AND NEW ORLEANS LINE
LOS ANGELES AQUEDUCT
SAN ANDREAS RIFT
PORTAL RIDGE
LEONA VALLEY
Elizabeth Lake
BOUQUET CANYON FAULT
BEE CANYON FAULT
SIERRA PELONA
PELONA FAULT
St Anthony's Ranch
Ritter Ranch
Anaverde Valley
Palmdale
Harold
Vincent
R 15 W
R 14 W
R 13 W
R 12 W
R 11 W
T 10 N
T 9 N
T 8 N
T 7 N
T 6 N
T 5 N
118°30'
35° 00'
34° 30'
118°00'

GEOLOGIC MAP
OF
ELIZABETH LAKE QUADRANGLE
BY
EDWARD C. SIMPSON

SCALE
1 0 1 2 3 4 MI

CONTOUR INTERVAL 500 FT
BASE MAP TAKEN FROM U.S.G.S. ELIZABETH LAKE QUADRANGLE
932

LEGEND

Quaternary	Qal	Recent alluvium
	Qs	Dune sands
	Ql	Playa deposits
	Qt	Terrace gravels, older alluvium
Tertiary — Rosamond	Tr	Miocene continental sands gravels, tuffs, limestone
	Trd	Miocene dacite flows
	Trb	Miocene basalt dikes and flows
Tertiary — Escondido	Te	Escondido conglomerates sandstones shales
	Teb	Escondido basalt and andesite flows
Tertiary — Martinez	Tm	Martinez lower Eocene sandstone and shale
Upper Jurassic	Jqm	Quartz monzonite and other acid intrusive rocks
	Jd	Hornblende diorite and granodiorite
Triassic	℞sh	Bean Canyon Series, schists slates, quartzites
	℞ls	Crystalline limestone of the Bean Canyon Series
Pre-Cretaceous	pKqd	Quartz diorite
	pKap	Monzonite aplite
	pKgr	Alkali granite and syenite
	pKgn	Gneiss
	pCsh	Pelona Schist Series quartz mica plagioclase schist mica schist, amphibole schist, quartzite, crystalline limestone

Faults, exposed
Faults, buried
Contact
Gradational contact
Axis of anticline

MINERAL DEPOSITS

(G)	Gold Mines
(Gr)	Graphite
(Gp)	Gypsum
(Mg)	Magnesite
(Fs)	Feldspar
(Qz)	Quartz
(C)	Clay

Borings for Petroleum
◇ Dry holes

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